POPULAR SCIENCE

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DECEMBER

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PROF. GODDARD'S TURBINE ROCKET SHIP FOR FLIGHT TO MOON

Page 63

Blacksmith Shop in the Ford village of Greenfield, Michigan

WHEN WE WERE YOUNGER

THE blacksmith's calm, ruddy face took on an astounded look when the first gas-buggy came to a jerky stop in front of his shop for service! Staring him in the face, was an idea new to the world!

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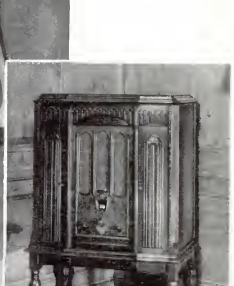

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POPULAR SCIENCE MONTHLY

381 Fourth Avenue
New York, N. Y.

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December, 1931, Vol. 119, No. 6. **Popular Science Monthly** is published monthly at 381 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Single copy, 25 cents (30 cents in Canada). Nine months' subscription in U. S., $2. Yearly subscriptions to United States and its possessions, $2.50; foreign countries, including Canada, $3. The contents of this magazine must not be reprinted without permission. The editors are not responsible for unsolicited contributions, and cannot guarantee the return of such material or insure against its loss. In presenting numerous stories of new products of applied science, **Popular Science Monthly** does not underwrite the business methods of the individuals or concerns producing them. The use of **Popular Science Monthly** articles for stock-selling schemes is never authorized. A. L. Cole, President and Treasurer; R. C. Wilson, Vice President; John Nichols, Vice President; F. W. Briggs, Secretary.

Popular Science Monthly for December, 1931

Everything's Electrified—*Ready for the* BOOM!

By LEON MEADOW, *Financial Editor*

"WE'VE seen the electric refrigerator, the electric radio, the electric washing machine, the electric clock and the electric 'what-not,'" said Bob Shuttleworth, with a smile.

"Yes, I know," answered Herbert Collins, somewhat annoyed, "but what's that got to do with my question? I want to know how a man's to choose a sensible investment these days, with everything crashing down the way it is—stocks, bank securities, preferred issues, bonds—everything!"

"I'm coming to that, Herb. In fact, I've already started to answer it. What I was driving at was the desirability of investing in public utilities—or, for the sake of a more particular example, in the electric light and power industry. For the long-term pull they seem to be the best investment a man can make any time—and more especially, today."

"Yes they do," interrupted Collins, scornfully, "look at the way they've come down—worse than the others!"

"Sure—but look at the way they went up in 1928 and 1929—much higher than the others. In those years they were so abnormally inflated that today they naturally have to come down further—and, as you say, they have. Now, listen—do you want me to go into this thoroughly—or shall we drop it now?"

Collins laughed. "I'm a great listener—and I know you're just aching to get something off your chest, so let's have it."

BOB SHUTTLEWORTH proceeded to give it to him. "First, you have to understand that whatever relationship exists between Business and the Stock Market, it must never be forgotten that Business is the dominant factor of the two. Business must form the basis for the Stock Market and not vice-versa. And, if the stock market functions in a normal way, then it should prove to be a fairly true reflection of business conditions. If it falls below or exceeds normal limits, then it ceases to be what it should be—an accurate barometer of underlying business conditions.

"For several years," Bob continued, "market prices failed to register their intrinsic values. Before the 1929 crash they were generally far above such values, just as today they are undoubtedly far below them. The realization of this condition will prevent you, or anyone, from coming to hasty and unjustified conclusions. If a group of securities in one particular industry declines on the market, it has not necessarily done so because of a vital change in the position or outlook of that industry. And that brings me to Public Utilities."

"And that's what I'm waiting for," put in Collins.

"As you know, public utility equities command a much lower market than they did two years ago when they reached their height. Yet, this depression hasn't altered the essential field of public service to any material extent. Of course, the regular growth of public utilities has been temporarily checked—and there have been slight declines in output and earnings here and there—but, compared to almost any other industry, the volume of utility business and sales has been affected to an almost negligible extent; certainly *out of all proportion to the market decline of its securities.*

"WHAT'S more," continued Bob, "Public Utility Companies have invested an unbelievable amount of money in science and research, for the sole purpose of cutting down consumer costs and preparing future fields of new uses for electricity. So tremendous have their efforts been—and so successful up to the present—that there probably isn't a sane person in this world who would risk his reputation by stating that the long term outlook for this industry does not continue to be an exceedingly bright one."

"You're right, Bob," said Herbert, "but how does that affect the investment question—is the time ripe now?"

"I'll take that up in a minute. First let me summarize the net of what I've told you. You'll find, then, the unique example of an industry which is, for one thing, only temporarily—and in a very small way—affected by the general business slump; and, for another thing, an industry inevitably headed for future growth and development.

"On this basis, the representative securities of this industry should be among the first to deserve particular attention as long term investments. The terrific drop in their market values is only to a fractional extent due to the retarded growth of their business. Almost entirely, it is the result of the readjustment of *previous* price levels, which in turn were caused by what we can only call an insanely absurd *over-discounting* of the future possibilities of the public utility industry. I wouldn't dare to predict the final lows to which utility securities may still have to sink in these uncontrollable times, but any sensible investor can do well by fixing a fair value for such securities, and then be content with a purchase price that does not exceed that value.

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EVERYTHING'S ELECTRIFIED— READY FOR THE BOOM

(Continued from page 4)

You can be sure, Herb, that an investment made on such a basis will not be regretted in future years—and even right now it isn't hard to see that several attractive opportunities do exist at current price levels. Even if you don't buy at absolute lows, over a period of years your investment is sure to have proven profitable."

"OF COURSE," broke in Collins, "your whole argument is based on the stability of public utilities as an industry—and, on the contention that their output and revenues have received little or no setbacks during this depression. Now tell me, Bob—is that just an argument, or have you actually based it on figures?"

"An argument?" Bob replied, smiling. "Why, Herb, I've a deskful of statistics right here to prove that the present setback in this industry—or, more particularly, in the electric light and power industry—is only of trifling proportions." Bob reached across his desk, picked up a sheet of paper and glanced at it. "According to The National Electric Light and Power Association," he said, "in 1930 the electric output for the country amounted to 74,906,092,000 kilowatt hours— or *only ½% less* than the 1929 output of 75,294,467,000 kilowatt hours —and *13.3% ABOVE* the total of 1928, which was 66,987,950,000 kilowatt hours. You see the significance of those figures, don't you?"

"What do you mean?"

"Industrially, economically, and in every other way 1929 was so abnormal that you might discount it entirely when attempting to compare most anything by years. But still, 1930, by no means a good year, shows a startling increase over 1928, which was a better than average year!"

"Now I see your point. But what about this year?"

"This year the decline is a little more marked, but still of slight proportions. For the first seven months of 1931 the electric output was 42,157,900,000 kilowatt hours—or 4% below 1930's first seven months figure of 43,902,055,000 kilowatt hours—and only 1.6% below the first seven months of 1929 when the output was 42,851,662,000 kilowatt hours.

"Now, if you want to analyze the situation further, here are figures that will do that also. Look at them:"

FIRST SEVEN MONTHS, 1931

(Kilowatt Hours)

Industrial Sales	35,291,654,000
Domestic Sales	6,866,246,000
Total Sales	42,157,900,000

(Continued on page 6)

EVERYTHING'S ELECTRIFIED— READY FOR THE BOOM

(Continued from page 5)

FIRST SEVEN MONTHS, 1930

Industrial Sales	37,524,346,000
Domestic Sales	6,377,609,000
Total Sales	43,902,055,000

FIRST SEVEN MONTHS, 1929

Kilowatt hours

Industrial Sales	37,279,651,000
Domestic Sales	5,572,011,000
Total Sales	42,851,662,000

"In other words," Shuttleworth pointed out, "the decline, small as it is, has taken place only in the industrial output, whereas the domestic output has not only held its own—but even increased. The important point about this is that since domestic sales are one of the mainstays of the average electric utility company, their revenues have maintained a satisfactory level. Look at these figures:"

GROSS REVENUES FROM SALES OF ELECTRIC CURRENT

First 7 Months, 1931	$1,154,281,500
First 7 Months, 1930	1,162,218,600
First 7 Months, 1929	1,107,793,700

Herbert Collins seemed convinced. "That is a remarkable showing," he said, after looking over the figures.

"AND even more remarkable," his friend replied, "when you realize that this industry has already been showing a large gain each year for a period of years—and still the figures are going up. What is true of the electric industry applies in general to the gas industry which, of late, has also expanded tremendously—due, of course, to the rapid increase in the use of natural gas for both commercial and domestic purposes.

"So you see, Herb, that the prevailing depression may temporarily limit the rate of growth—but it cannot stop the continued expansion of the utility industry. Every year dozens of new applications of power to old products call for new uses of electricity. As to the existing and established applications, there is still a tremendous field. The use of electric refrigerators is still increasing rapidly. Electric washing machines, electric and gas cooling equipment, electric oil-burners are still far from their saturation point. The average residence of today has several times the amount of electrical outlets it had ten years ago—and the future outlook is for still more. Remember, then, that there may be a temporary lapse of prosperity, *(Continued on page 7)*

EVERYTHING'S ELECTRIFIED— READY FOR THE BOOM

(Continued from page 6)

but there can be no halt to progress, and that's the watchword of the utilities industries.

"From the way I look at it," concluded Bob Shuttleworth, "I feel perfectly safe in repeating what I said previously—namely, that the sensible investor, with his feet on the ground, must not allow himself to be totally blinded by the spectacular movements of the present stock market. These wild, day-to-day fluctuations cannot alter the fact that the public utility industry—particularly in its electric light and power division—has not lost one particle of its long-term attractiveness for average investors—and, to use a very hackneyed phrase, is still as nearly 'depression-proof' as any other industry in the country."

To Help You Get Ahead

THE booklets listed below will help every family in laying out a financial plan. They will be sent on request.

Your Income and Your Life Insurance is the name of a brief booklet scientifically answering the question "How much life insurance does a man really need?" Provident Mutual Life Insurance Company of Philadelphia, Pennsylvania, will mail a complimentary copy upon request.

Before 65 and After explains the full details of a Retirement Income, with full Life Insurance, Disability and Double Accident benefits. Sent on request by The Equitable Life Assurance Society, 393 Seventh Avenue, New York City.

How to Get the Things You Want tells how you can use insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

Enjoy Money shows how the regular investment of comparatively small sums under the Investors Syndicate plan, with annual compounding of 5½% interest, builds a permanent income producing estate, a financial reserve for a business, or a fund for university education or foreign travel. Write for this booklet to Investors Syndicate, Investors Syndicate Building, Minneapolis, Minnesota.

See How Easy It Is tells how it is possible to start off with a definite plan for creating an immediate estate leading to future financial security. Get your copy of this booklet by writing to Postal Life Insurance Company, 511 Fifth Avenue, New York City.

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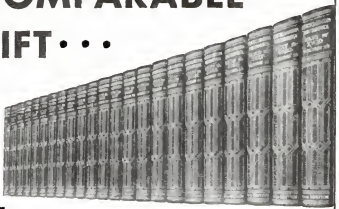

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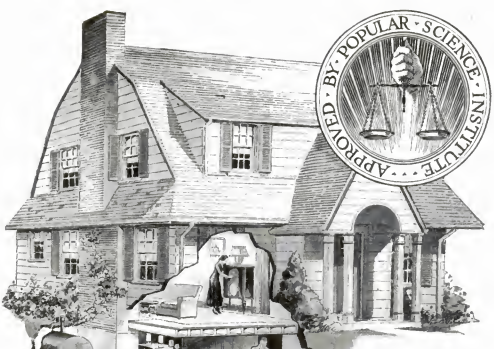

Radio sets, oil burners, and tools are being bought for many modern homes today. Aid in their selection will be given by Popular Science Institute investigators

Protection *for* Buyers

BUYING these days is done with considerably more care and thought than used to be the case, but when up against the problem of selecting equipment about which one knows little, it takes more than care and thought to make a wise choice. It means that someone else's judgment must be relied upon, and to fill this need for sound and impartial advice is the purpose of the Popular Science Institute.

The Institute is not ready to give out advice on all types of products, but it thoroughly investigates three classes of equipment that present problems to the buyer and in which particular interest has been evidenced by POPULAR SCIENCE MONTHLY readers. If it is a radio set, any kind of hand tool, or oil burner that you are buying, it will be worth your while to check with the Institute and find out if the make you are considering is efficient and worth the price asked. These products represent a good sized investment and are difficult to judge. One can afford to learn by experience in buying the smaller things that have to be replaced frequently, but not many can afford to gamble on a major purchase.

Popular Science Institute goes to great lengths in the way of laboratory test and investigation to answer these two questions about a product: "Does it satisfactorily fulfill the purpose for which it is intended?" and "Does it represent good value?" Experts who have seen the Institute's tests under way at the laboratory at New York University know how definite an answer is obtained to these questions, for, invariably, visiting engineers comment upon the completeness of the tests, the quantity of expensive testing equipment available, and the ability and knowledge of the Institute's testing staff.

New readers of the magazine sometimes ask what the Institute is and what it does. To aid readers in their buying problems, to determine that only reliable products were being advertised, and to make POPULAR SCIENCE MONTHLY a still better magazine were the three aims the publishers had in mind in establishing Popular Science Institute.

THE Institute has been functioning for eight years, and its aims not only have been fulfilled, but the Institute has been able to branch out and serve in some other capacities that had not been anticipated in the early days of its organization. Professor Collins P. Bliss, Director of the Institute and Dean of the College of Engineering at New York University, has been called upon by Government authorities at Washington to assist in several projects where information accumulated by Popular Science Institute was useful. Dean Bliss is now consulting mechanical engineer for the U. S. Bureau of Standards and active on several committees whose work deals with equipment of the type investigated by Popular Science Institute.

AS TO the principles by which the Institute is governed, it must, and does, present only the facts discovered. It is obvious from the type of tests conducted that information of the most complete and accurate nature is obtained regarding each product investigated. Likewise it is obvious from the character of the men who direct the work of the organization that any judgment passed on products is impartial and can be relied upon. Nothing except the evidence produced by its tests and investigations serves as basis for approval or disapproval. Most of this evidence is in figures, thereby eliminating personal opinion to the greatest extent possible. While no disapproved product may be advertised in POPULAR SCIENCE MONTHLY, this is the only particular in which advertising features. Any manufacturer of nationally sold equipment, available to our readers in all sections of the country, may have his products tested by the Institute without charge and without obligation in any respect.

The Institute advisory service is available to all readers, as are the several bulletins that it issues. Questions regarding oil burners, tools, or radio sets, or requests for approved lists of such equipment, should be addressed to Popular Science Institute, 381 Fourth Avenue, New York, N. Y.

INSTITUTE BULLETINS

Heating and Ventilating*
Insulation in Building Construction*
List of Approved Tools
List of Approved Radio Sets
List of Approved Oil Burners
Advice on Installing Oil Heat
Refrigeration for the Home*

*Starred bulletins 25 cents

FOR THE HOME OWNER

Two Booklets Contain Much of the Information You Need in Building or Modernizing a House

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There are special chapters on heating with coal, oil and gas which contain comparative data on cost and advantages, as well as the essential facts that need to be known if you are considering the installation of an electric stoker, oil burner or gas heating system.

Automatic heat control, room heaters, humidity, ventilation and summer cooling are other subjects treated in this booklet and, throughout, are illustrations showing various types of modern equipment.

Insulation in Building Construction covers a subject that many buyers and builders of homes need to know about. Many houses are represented as being "insulated" when they are not really insulated at all.

This booklet explains in dollars and cents just what insulation does in saving heating costs, as well as providing comfort at all seasons. From the facts given, you can decide whether insulation is a worthwhile investment for you.

Detailed description is given of the various insulating materials, their comparative rating as regards efficiency in stopping heat flow, and other factors that need to be considered in selecting insulation.

One section of the booklet describes how to insulate houses that are already built and a final chapter deals with the curbing of heat loss through use of weather-stripping, calking compounds, etc.

These booklets have been prepared by the engineers of Popular Science Institute. They may be had by sending 25 cents for each to Popular Science Institute, 381 Fourth Avenue, New York, N. Y.

Statement of Ownership, Management, Circulation, etc., required by the Act of Congress of August 24, 1912, of Popular Science Monthly, published monthly at New York, N. Y., for October, 1, 1931, State of New York, County of New York, ss. Before me, a notary public in and for the State and county aforesaid, personally appeared A. L. Cole, who, having been duly sworn according to law, deposes and says that he is the Business Manager of Popular Science Monthly and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 411, Postal Laws and Regulations, printed on the reverse of this form to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Popular Science Publishing Co., Inc., 381 Fourth Avenue, New York, N. Y., Editor, Raymond J. Brown, 381 Fourth Avenue, New York, N. Y., Managing Editor, Raymond J. Brown, 381 Fourth Ave., New York, N. Y., Business Manager, A. L. Cole, 381 Fourth Avenue, New York, N. Y.

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(Signed) A. L. Cole. Business Manager.

Sworn to and subscribed before me this 17th day of September, 1931.

Esther Kyl, Notary Public, Kings County Clerk's No. 57, Register's No. 2065. New York County Clerk's No. 156. Reg. No. 2B117.

(Seal) My Commission expires March 26, 1932.

Our Readers Say

Why Not Count Them and Get the Thing Settled?

LET me add the last chapter on the 365-366 day argument: Suppose I am riding the hobbyhorses. They turn to the right. I try to keep my eyes on a pretty girl standing in the crowd. To do this I must turn backward as I go around. Suppose I try to turn in the opposite way and still keep my eyes on the lady. I doubt if even a cross-eyed astronomer could do this. To turn in opposite directions at the same time is, I believe, as hard as to walk on one's head. If the earth turns backward sometime while it makes 365 turns in the right way, I believe Gov. Murray ought to be notified and something done about it; such things shouldn't be permitted.—D. G., Hale Center, Texas.

Altogether Now: Is That the Right Place for the Fence?

J. V. M., ALTOONA, Ala., can locate his fence by measuring approximately 58.66 feet along one of the legs starting from its intersection with the twelve-foot base, and through the point thus found, erecting his fence parallel to the bases. . . . I have been greatly interested to note the increasing number of mathematical questions and puzzles which have been offered voluntarily by your readers in the columns of "Our Readers Say" during the past months. In view of the interest already shown by your readers, and considering the fact that "math" is the basis of all science, I feel that you would be making no mistake were you to devote a few paragraphs each month to some phase of this subject. Such a department would, I think, be of mutual benefit both to your magazine and to its readers. Small prizes might be awarded in order to insure keen competition in the contests. Come on, you "math" enthusiasts; let's hear what you have to say about such a feature. Or am I the only one in the world who would be interested in such brain teasers?—J.B.F., Manchester, N. H.

He Knows the Beetle That Throws Out a Smoke Screen

ON "Our Readers Say" page recently, I noted a letter from J. C. L., Iron Mountain, Mich., relating an experience with a peculiar type of beetle. It is evident that J. C. L. met the Bombardier Beetle, a beetle that discharges a drop of fluid that changes to a smokelike gas on contact with the air. This gas changes the blue vegetable colors to red or yellow, produces a sharp pain when applied to the tongue, and leaves a yellow spot on the skin like that produced by nitric acid. I don't blame the Indian for not wanting to investigate further, as most any of us would retreat if we got a shot of nitric acid in the face. More than twenty-five species of these beetles are known here.—G.G.L., Berkeley, Calif.

New York Hastens to Answer Questions from India

IN REPLY to the two questions asked by V. K. R., Satara, India, I would say: The answer to the first depends upon how high the airship rose. If it remained in the earth's atmosphere it would be carried along with it. When it landed, it would probably be on the same spot from which it rose. If the airship left the earth's atmosphere, when it came down after twelve hours it would probably land on the opposite side of the earth from which it rose. The answer to the second question is that the bullet would hit the man. The reason is the bullet had a velocity, relative to the ground, of 600 miles per hour. Therefore, it would hit the forward man at 300 miles per hour if air resistance and gravity are not counted.—L. C. R., New York.

Parting Goats from Sheep Among the Star Gazers

I AM glad to see there is someone with backbone enough to knock the astrologists. But where are our hawk-eyed minions of the law and our much talked of wide-awake postal inspectors? Aren't the astrologists using the mails to defraud? It is really disgusting to think that in this day and age such things as astrology, palm reading, crystal gazing, and fortune telling are allowed to exist. What would become of us if someone really could foretell the future? If these people were able to do what they pretend, could they not make enormous fortunes without bothering to read the horoscopes of others?—N.G.D'A., Philadelphia, Pa.

With great interest I have read the article by Jesse F. Gelders on fake astrology. If by such attacks and exposures you can help rid the world of fakes you will do a great service. But why will you not learn the truth and beauty of Astro-logic and then publish intelligent articles about it? In the star science, all sciences are embodied. The evolutionary process of the earth and mankind is written there in symbols, allegory, and numbers—the very mystery of life and being. But such deep truths are not revealed to the casually curious.—Mrs. A.L., Crestline, Calif.

"Origin of Life" Articles Just Suit Him Fine

I SHOULD like to congratulate you on your excellent publication. I have been particularly interested in your series of articles on "The Origin of Life." I have gained more from this series than I did from six months of study of dry, uninteresting textbooks. I think a monthly article on simple experimental chemistry would be welcomed by a great many of your readers. I should also like to see a section devoted to pure mathematics. This field surely would have a popular appeal, especially if the problems of antiquity, the squaring of the circle, the reduplication of the cube, trisecting of the angle, etc., were discussed.—L.F.E., Hartford, Conn.

He Wants "Mind" to Reform This Wretched Old World

CAN you not give us something on the science of "Mind?" This seems reasonable, as the mind is the source of all science. Of course, the psychologists are ever ready to sell books and I have studied quite a good bit on this interesting subject, and it is wonderful as you know. If we could get more people interested in this subject, so they would know more about themselves, the world would soon make a change for the better. "Son of man, know thyself," that's my motto.—J.E.S., Indian River City, Fla.

Built His Own Hydroplane And, Boy, He Likes It!

IN YOUR March 1931 issue of P.S.M., page ninety-two, there appeared an article by William Jackson giving instructions on making an outboard motor hydroplane. I built this boat and it proved satisfactory in every respect, and as a result my enthusiasm for this branch of sport and recreation has been increased at least a thousandfold, and it is my desire now to build another with which I can get still more speed. I surely enjoy P.S.M., all of it, but I never could find words that would adequately express my thanks to "her" and you for the thrills and fun I have derived as a result of Mr. Jackson's contribution.—A.P.S., Bristol, Pa.

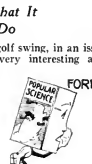
High Hat? Our Workshop Never Even Heard the Words

WHAT I want to say is, why the high hat in the Home Workshop Department? If you don't own a motor-driven circular saw you're out of luck. Personally I'm trying hard to get the money to buy one, but in the meantime I read your wonderful articles and I just itch for the tools to build the things you describe. First of all, you should remember that not every reader of your cleverly edited publication has the money to buy expensive machinery. Here's my suggestion: Why doesn't POPULAR SCIENCE MONTHLY issue a card which will entitle its subscribers to a ten percent discount on anything we buy that is advertised in your magazine? It seems to me this would please everybody—you, the advertiser, and us. Think this over. Also, why is it I have never seen a section of your pub-

lication devoted to drafting? I wish you would teach us, through a new department, how to draw and how to read blueprints.—D.J.S., New York, N. Y.

That's Exactly What It Was Expected to Do

YOUR article on the golf swing, in an issue some time ago, was very interesting and instructive. I found it so helpful that I have passed the magazine to quite a number of the members of our country club and now it is getting all ragged and worn, but the instruction in the golf article certainly improved the golf of everyone who read it, including mine. —O. T. M., Walkerton, Ont.



Here's the Real Low-Down on That Fairy Cross Business

AS A geologist, your recent article about the Fairy Crosses of Virginia shocked and amazed me. Almost any good book on mineralogy will tell you that good specimens of staurolite may be found in many countries scattered throughout the world. The best come from Brittany and Georgia. I have found a number of them in South Carolina. Staurolite is produced by the intergrowth of two crystals in twinned position. Your author was correct in stating that they are an aluminum-iron silicate, but this is not necessarily the case, as other metals are sometimes found in their chemical composition. They are of a dark brown color, usually dull and opaque. Staurolite is not the only mineral that takes the peculiar form of twinned crystals. Gypsum and fluor spar are also intergrowths of crystals at right angles. —H.P., Florence, S. C.

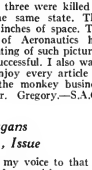
Airplane Crashes No Longer First-Page News to Him

I AM writing to complain about the publicity that airplane crashes receive. A few weeks ago two Army planes crashed. Two were killed and the other two pilots jumped and lived. The papers carried front-page headlines and printed pictures of this accident. On the same day, three were killed in an auto mishap in the same state. This tragedy was given two inches of space. The Connecticut Chamber of Aeronautics has tried to prevent the printing of such pictures, but so far has been unsuccessful. I also want to assure you that I enjoy every article in your magazine except the monkey business by Mr. Mok and Dr. Gregory.—S.A.C., Danbury, Conn.

All About Pipe Organs in December, 1929, Issue

I SHOULD like to join my voice to that of "B.E." in supplication of an article concerning large pipe organs.

I think an article of this type would be of popular interest to many of your readers. Your article on the discovery of the new element was interesting, but I should like to see something like this more often. There cannot be too many articles on chemistry to suit me, and I have an idea from what I have seen that there are hundreds of others exactly like me in this respect.—D.F.F., Bellefonte, Pa.



Real Glider Club Now on the Job in Connecticut

THINKING it might be of interest to your readers, I am writing this to tell you that we recently organized a glider club here under the name of The Stamford Gliding Club. It was organized for the purpose of promoting motorless flight in Stamford and vicinity. It is the first of its kind to be organized in this district and we feel that its success is assured. We bought a primary type glider in knockdown condition and assembled it ourselves. We have it nearly finished and expect to have it in the air very soon. At each meeting of the club a ground school lecture is given on some phase of aviation. —E.B., Stamford, Conn.

Byrd is Nominated as World's Greatest Flyer

REGARDING your request for opinions as to the world's greatest flyer, I want to check and double-check the nomination of Rear Admiral R. E. Byrd for this honor. After seeing the motion picture of his flight to the South Pole, I don't see how anyone could think anyone else a greater flyer than he.—L.K., Brooklyn, N. Y.

Can You Get This Vacuum and Cylinder Thing Straight?

H. L. C. IN the October issue of POPULAR SCIENCE MONTHLY suggests an idea for a vacuum blimp. He says fill a very light shell covering with light spheres or cylinders to stand the outside atmospheric pressure and pump the air out of the small cylinders, thus making a near vacuum that would be lighter than hydrogen or any other gas. It is true that the vacuum would be lighter than any gas known; in fact, the vacuum would weigh nothing. But we must not forget that our cylinders would weigh something. No matter what metal it is made of, it would not be lighter than air. One liter of helium weighs (at 0° Centigrade) 0.1785 grams; one liter of hydrogen weighs 0.08987; one liter of air weighs 1.2930. By these figures we can plainly see why balloons raise. If I am wrong will you please let me know. —J.D., Syracuse, N. Y.

Well, That's All Right; They Amazed Us, Too

I NEVER saw anything more amazing than your article on cannibal germs, I simply ate it up and can't get it out of my head. What I want to know now is: Do scientists think they can eventually win the fight with these tiny, destructive things that cause so much sickness; or will humanity, some time, be wiped out by a germ that, as yet, may not have been discovered? I should think this might happen, though Dr. Kendall's work should go far toward preventing it. Seriously, it seems to me that the big job scientists now face is to save mankind from destruction by the insects. If I'm wrong, stop me. But I wonder if they can do it, and if so how.—C.W.G., Bronxville, N. Y.

Jiggling Skyscrapers Have Him Puzzled

IF THE earth is so big and sturdy, why do skyscrapers weave and jiggle around at the top? Can any of our readers tell me? Also I wish some of the wise ones would tell me why the Gulf Stream is changing its course and why New York City has no more blizzards as it did in 1888 when there were no high buildings. Why did Miami, Fla., have such a cold winter last year? The Empire State Building was not built the year before and so the weather was warmer. Is that the answer? I wish somebody would tell me. —R.P.S., Saratoga Springs, N. Y.

What's a Knock or Two Among so Many Boosters?

I THINK you must publish the opinions of the knockers only, so that your "Readers Say" page won't seem too much like a testimonial meeting. Otherwise, I believe, you would be the charitable to put the opinions of such "smart" people right out in public print where everyone has a chance to read them. Is that so? But some of the knocks give us faithful ones a big laugh.— E. M. W., Independence, Kansas.

This "Mere Mechanical Toy" Was Fifty Feet Long!

WOULD it ever occur to you that you could devote space to something more interesting than a mere mechanical toy devised for the purpose of luring people to a silly show? I'm not criticising Seielstad's drawing. He's the early spring berries as far as that goes, but I hate to see him waste his talent on such a trifle. It just kind-a gripes me when I see any sort of a suggestion that men and dinosaurs lived at the same time and fought for the possession of the interglacial jungle. It ought not be hard to remember that these great beasts were gone thousands and thousands of years before anything even faintly resembling man appeared on earth. That being so, how in the name of common sense could the monster be running round with a clothed or even partially clothed young lady in its mouth? It just doesn't stand to reason unless I'm getting cock-eyed in my old age. And anyway, if by some freak of nature a girl had strayed into the dinosaur age, it's a perfectly safe bet of a million to one that she'd have been clotbed in just exactly nothing or quaintly wrapped in a rapidly decomposing piece of hide. Am I right? You can put it on the line that I am. But there seem to be a lot of folks who think that when life appeared on this earth men were there to watch it grow. Can't they get it into their heads that humanity is one of the youngest forms of life and that most of the prehistoric monsters had disappeared long before we were even some form of hitherto undiscovered monkey? But I can't end this squawk without taking time to tell you that on the whole and by and large, I'm for POPULAR SCIENCE MONTHLY from hell to breakfast—and back again.—C.C.B., Cape May, N. J.

Pity the Poor Scientists With All the Elements Found

Now that "Eka-Iodine" the missing element, No. 85, has been discovered, thus completing the periodic table of elements, I presume scientists will devote their spare time searching for new vitamins to complete the alphabet. But do you suppose that all the elements have been discovered? Even so there are many fields left for scientists to work in without trying to prove that man came from a monkey or his face from a fish.—H.E.A., Richmond, Me.

Enroll Today

in the

FISHER BODY CRAFTSMAN'S GUILD

$75,000 IN AWARDS

Four University Scholarships ✦ ✦ ✦ 116 Trips to Detroit 1120 Gold Awards

Every boy in the United States and Canada, between twelve and nineteen years of age inclusive, is eligible. Begin today by enrolling with any General Motors car dealer

Every boy who enrolls *now* in the second Fisher Body Craftsman's Guild competition will have the advantage of an earlier start in the construction of his model coach. Remember, the Guild competition for 1932 offers even greater opportunities for boys throughout the United States and Canada.

The conditions of the second Guild competition are the same as those of last year's. All boys in the United States and Canada between 12 and 19 years of age inclusive are invited to take part. There is no entry fee or enrollment charge of any kind. Every boy who enters the competition will construct a miniature model Napoleonic coach, from detailed plans and instructions furnished free by the Guild. The judges, both State, District and International, will be men of the highest standing in the knowledge of fine craftsmanship. At their head, as Honorary President of the Guild, is Daniel Carter Beard, beloved National Boy Scout Commissioner, and John A. Stiles, Dominion Commissioner for Scouting, as Honorary President of the Canadian Section.

The awards for the second Guild competition should be an inspiration to every ambitious boy. Remember, there are four $5,000 university scholarships, 116 trips to Detroit and 1120 gold awards awaiting the winners. Why not join the Fisher Body Craftsman's Guild at once—today—and get an early start toward success?

Enroll NOW with Any General Motors Car Dealer

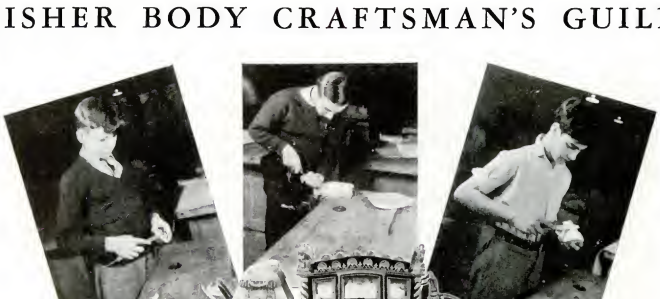
It is very easy to join the Fisher Body Craftsman's Guild. Just go to any dealer in General Motors cars and say you want to enroll.

Dealers in Cadillac-La Salle, Buick, Oldsmobile, Oakland-Pontiac and Chevrolet are all General Motors car dealers. There is one in your community.

As soon as your enrollment is registered, you will receive from Guild headquarters your membership card and official Guild button, and a complete manual containing scale drawings of the model coach, instructions for building it, pictures of the coach in full color, and all other information pertaining to the Guild.

If you entered the first Guild competition, try again! (Memberships must be renewed.) If you missed the first chance, by all means get in this time. Enroll NOW and get an early start!

FISHER BODY CRAFTSMAN'S GUILD



Pictured above is the miniature model Napoleonic Coach, together with photos of three of last year's Guild members working on their models

INTERNATIONAL AWARDS

Four University Scholarships of four years each

Two of these Scholarships go to Juniors (12 to 15 years inclusive) and two go to Seniors (16 to 19 years inclusive).

Ten Awards for Seniors and Ten Awards for Juniors in Every State and Canadian Guild District as follows:

1st State or District Award . . . . . Trip to Detroit and $100 in gold
2nd State or District Award . . . . . $100 in gold

1st State or District Woodcraft . . . . . $ 25 in gold
2nd State or District Woodcraft . . . . . $ 15 in gold

1st State or District Metalcraft . . . . . $ 25 in gold
2nd State or District Metalcraft . . . . . $ 15 in gold

1st State or District Trimcraft . . . . . $ 25 in gold
2nd State or District Trimcraft . . . . . $ 15 in gold

1st State or District Paintcraft . . . . . $ 25 in gold
2nd State or District Paintcraft . . . . . $ 15 in gold

Every Guild member who submits a completed coach on or before midnight, July 1, 1932, will receive the Guild Certificate of Craftsmanship.

PRESDWOOD
works with Santa Claus

Countless homes will be brightened this Christmas with gifts that Masonite Presdwood helped make...beautiful, durable gifts that come from factories all over the world.

The makers of these articles are Presdwood enthusiasts. Naturally! Presdwood is bettering their products, cutting their costs, speeding up their production. Articles such as those shown on the right, and many others, are being made of Presdwood with great success.

The men at your presses, planers, drills and saws will take kindly to these modern industrial boards. So will the machines themselves—and the men who work with hand tools. You'll have little concern over waste and rejections, for Presdwood is rigidly graded at the mill.

Get acquainted with Presdwood, the smooth, grainless, water resisting board that doesn't crack, chip, split, splinter or warp. Use it in your factory. The free Presdwood booklet will give you the complete story. Write for your copy today, or consult your lumber dealer.

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PRESDWOOD
STRUCTURAL INSULATION · INSULATING LATH
QUARTRBOARD · *Cushioned*, FLOORING
"Made in Mississippi"

Presdwood makes an ideal bed for juvenile billiardtables, says the Brunswick-Balke-Collender Co., Chicago

Toys made by "Ploy-Skool", Inc., Milwaukee, Wis., are better because they're made of Presdwood

Presdwood serves perfectly for backs of electric refrigerators manufactured by Servel, Inc., Evansville, Indiana

Valleyco Company, Cincinnati, use Presdwood, with slate finish, to make ideal blackboards

At RCA Victor Company, Inc., Camden, N. J., the backs of radio cabinets are cut from Presdwood

Sturdy, attractive toys are made of Presdwood by the H. M. Miller Company, Jeannette, Pa.

Masonite *Cushioned* FLOORING of TEMPERED PRESDWOOD

This new, all-wood flooring with the in-built shock absorber offers tremendous advantages in beauty, durability and convenience. Outer layers of Tempered Presdwood assure beauty and long life. Inner layer of Quartrboard provides resiliency, insulation and sound absorption. Tongue-and-groove construction makes perfect, interlocking joints. Two-color reversible squares and borders make possible endless variety of design. Send for booklet describing this modern flooring.

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Please send your free illustrated booklet that describes Masonite Presdwood and its many uses.

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☐ If interested in Cushioned Flooring, check here.

POPULAR SCIENCE
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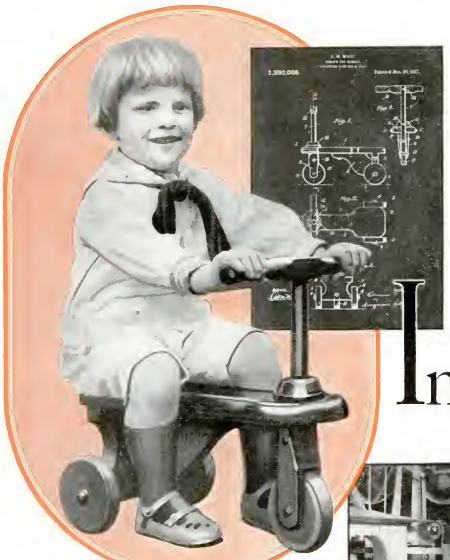
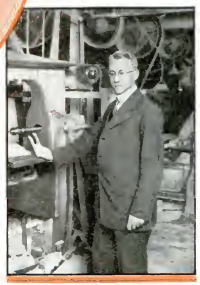
December 1931 Vol. 119, No. 6
RAYMOND J. BROWN, *Editor*
FOUNDED 1872
SIXTIETH YEAR



Big Fortunes won by Tiny Inventions

By
AUBREY D. McFADYEN
Associate Examiner U. S. Patent Office



Above, the first kiddy-kar, built to keep this child from breaking his other toys. At right, Clarence W. White, its inventor, and, at top, the Patent Office drawing

IMAGINE an inventor revolutionizing an entire industry by boring a quarter-inch hole in a steel pipe!

A recent court decision upheld the patent of the Pennsylvania workman who turned that almost magical trick. Twelve years before, he had added a small air vent to the mold pipe of a glass-blowing machine and patented his improvement. It converted a previous flop into an amazing mechanism that cut the cost of making window glass to a fraction of the former figure.

The owners of the patented machine which he had improved sued him for infringement. The judges held that he was guilty of no such thing. In a thrilling climax to a long and bitter legal battle, they handed him the victory and went out of their way to praise him. By conceiving this minor change, they said, he had lifted an invention from flat failure to sensational success, saved the window glass industry, and performed a "veritable miracle."

And so he had. The old machine drew cylinders of molten glass from a tank by feeding compressed air through a mold pipe. It was a fiasco, because the shape and thickness of the cylinders were largely matters of chance. Since the new air vent regulates the pressure in the pipe, smooth columns of glass of predetermined thickness now rise to a height of forty feet from the melting pots in glass factories. With the improved machine, seventy men can do the work of 600. As a result, more than two thirds of all window glass in this country today is made by machinery, and the price has been considerably reduced.

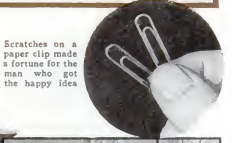
While this is one of the most striking instances of big oaks from little acorns in the field of invention, it is by no means unique. An investigation I have just completed of the records of the Patent Office has shown me that an impressive number of successful inventions, some of

Here is Bell's first telephone, an adaptation of an early instrument that could transmit only music

Scratches Worth a Gold Mine!

WOULD it occur to you that a man could make a great invention by boring a hole in a section of pipe or putting scratches on a bit of metal? This remarkable article, written by an expert of the United States Patent Office, tells how great fortunes were founded and great industries saved by trifling, and at times invisible, changes in machines made by men of vision and skill.

—The Editor

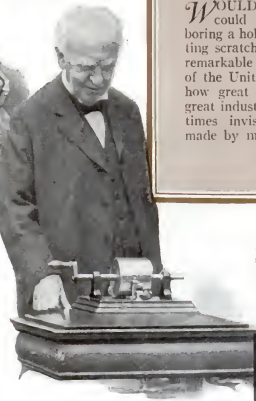


Scratches on a paper clip made a fortune for the man who got the happy idea

them used daily by every reader of POPULAR SCIENCE MONTHLY, grew out of minute, sometimes almost imperceptible, changes in older devices.

The new feature may have consisted in a hole, a slot, a notch, or even a scratch; the substitution of one material for another; a slight alteration in design; or the merging of two familiar contrivances into a new machine. In some cases, the changes were not structural, but mechanical; that is, no alterations were made in the old machines at all, but they were made to run in new ways.

Inventions perfected in this manner, I found, range from some of the world's greatest technical achievements down to several of the little knickknacks you handle every day. In each case, a small and apparently obvious change, sometimes so simple as to seem almost ridiculous, spelled the difference between success and failure and, oftener than not, brought a fortune to its inventor.



Thomas A. Edison with the phonograph that he invented. The needle traveled in a groove up hill and down dale and gave a weak and distorted reproduction

Dr. Irving Langmuir did away with Edison's vacuum in electric lights and filled the tube with nitrogen, cutting current consumption

OUTSTANDING among all inventions that were consummated in this way is the telephone. It is generally believed that Alexander Graham Bell invented it, but that is not the fact. He perfected it. Philip Reis, a German scientist, invented a telephone transmitter in 1863, thirteen years before Bell patented his instrument. Reis's crude apparatus could transmit a musical tone, but it could not transmit speech. It was Bell who made the telephone talk.

This he did by a slight adjustment. Reis's telephone was a circuit-breaking instrument; that is to say, it had two electrodes, or contact points, that opened and closed the circuit in the manner of the simplest kind of electrical switch. As a result, the sound into which the electrical impulses were translated, when heard at the receiving end, was either full strength or cut off entirely, just as lights are put on or off by means of the switch in your wall but cannot be turned on half strength in that fashion.

Bell changed the circuit-making and breaking into a current-varying operation. For Reis's electrodes he substituted a metal rod attached to the diaphragm and vibrating with it, and a fluid which was a good conductor of electricity and in which the rod moved up and down as it vibrated.

This seemingly small change produced marvelous results. It made the circuit continuous, thus making possible modulation of the current, which was increased or decreased according to the depth to which the vibrating rod was plunged into the fluid conductor. This enabled the telephone to transmit spoken words.

Later, the telephone was modified. The present instrument again has the electrodes, between which is placed a small container filled loosely with granules of carbon. Alternately compressed and released by a plunger, the carbon performs the same service as the rod and liquid arrangement because of its varying electrical resistance. But it is on Bell's original changes that the success of the telephone, and the tremendous wealth it has created, really rest.

The electric light, too, is a product of inventive evolution. The incandescent lamp is commonly credited to Edison, but little except the basic principle of the original invention—the carbon filament glowing in a vacuum—is left in the present bulbs. As a matter of fact, this principle was known to others before Edison produced a successful electric light through his discovery that carbonized bamboo made a practical filament.

Two small but vitally important changes are responsible for the efficiency and success of today's electric light. First, in 1912, came the Austrian chemists Alexander Just and Franz Hanaman, and substituted tungsten for Edison's carbon filament. This almost doubled the lamp's life and efficiency. Then, in 1916, Dr. Irving Langmuir, a scientist of the General Electric Company, did away with Edison's vacuum by filling the bulb with nitrogen gas. This, among other things, again cut current consumption practically in two.

Fortunes are not made exclusively through such great inventions as the telephone and the electric light. Solving the simplest little problem may make a man rich, provided the solution meets a universal need.

As an example, consider the lowly garter. Nowadays, a rubber or rubber-covered button is a feature of almost all hose supporters. Millions upon millions of people everywhere have rewarded Robert Gorton, of Plainfield, N. J., with good, hard cash for thinking of substituting this rubber button for the wood or cloth-covered button previously used in garters. The old wooden buttons would let the sock or stocking slip, and tended to tear it besides. The rubber button takes a firm grip, does not cause the stocking to

slip or tear, and, because of its resiliency, will hold hose of different thickness.

An even smaller change, somewhat similar in result, is said to have made a fortune for the man who conceived it. He is Clarence C. Collette, of Amsterdam, New York, the holder of a profitable patent on an improved paper clip. The difference between the new clip and the old one is simply that the Collette clip is provided with tiny nicks, scratches in the metal, that give it a rough surface and prevent papers from slipping out of the fastener.

Another article with which everybody is familiar and which owes its existence to a fairly obvious change in an older invention, is the "kiddy-kar." This toy vehicle, of course, is nothing but a modified tricycle. What Clarence W. White, its inventor, did was to make it so low to the ground and its seat so long and so broad that even very small children could ride it in comfort and safety. The curious part of this invention is that its great success is due to the very fact that it is not an improvement on an older device but a more primitive adaptation, since it is not propelled by pedals but by the rider kicking himself along the ground, and is made of wood instead of metal.

Above, the phonograph invented by Emile Berliner, seen at right, which was merely a modification of the Edison machine and, as patent diagram, right, shows, substituted a lateral groove for ups and downs in Edison record

THE toy's origin, by the way, explains its primitive character. White, a manufacturer of stereoscopes in Vermont at the time, made his first kiddy-kar for his small adopted son simply to prevent the child from riding on and breaking toy fire engines and other little wagons that had been given to him as Christmas presents. Other children liked the toy so much that White applied for a patent in 1915. In the first nine years, more than 3,250,000 cars were sold.

Imitators were not slow in trying to cut in on White's profits, and similar toys of various kinds flooded the market. When sued for infringement by White, one of these manufacturers made the defense that the kiddy-kar was not an invention at all, but an obvious revamping of an old mechanism and, therefore, public property, like a wagon.

The court upheld White's patent in a noteworthy decision. Children, said the judge in effect, have not changed, and two hundred years ago would have liked to push astride a little tricycle as much as they do today. The means have always been at hand, but White's insight and imagination, which others lacked, enabled him to use these means. The kiddy-kar, the court held, is an invention just because it is so simple that it had not occurred to anyone before. Invention must not be gaged by the necessary physical changes, the judge declared, so long as some are made, but by the directing intelligence which alone can conceive them.

This decision clearly reflects the attitude of the Patent Office and the courts toward inventions growing out of changes. Time and again, in infringement proceedings and other patent fights, the courts have ruled that the question is not whether the change is big or small, the achievement difficult or easy, but whether it has given the world something of real value that it did not have before.

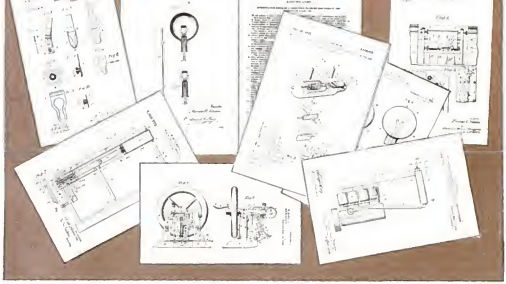
Not long ago, the Court of Appeals of the District of Columbia upheld the patent of a man whose sole invention consisted in boring a hole in a nut! The mechanism in question involved a heavy drill arm to which a nut was attached. The arm was moved up and down by a large screw taking hold on the nut so that the screw's rotation caused nut and drill arm to travel along the screw.

The purpose of the hole was to permit inspection of the wear on the threads of the nut, which was carrying a heavy load. Without the hole, the device had to be dismantled for inspection. If this was neglected, the threads might wear down to a point where the big drill arm would fall.

All this the court took into consideration. "This inventor," said the decision, "has done more than merely drill a hole in a nut. He conceived the idea of drilling such a hole as to permit inspection of the nut; and this, in our view, involved more than mechanical skill."

Practically the same view was taken by another court in deciding the fight of two piano companies over the little pointer, or controller, that enables any layman to reproduce a master pianist's interpretation of a piece of music on a player piano. When the pointer is made to follow certain lines on the record, or music roll, the mechanical piano plays the composition in the manner of Paderewski, or any other great artist who happened to make the record.

This remarkable device is the invention of Francis Lincoln Young, an American living in London. The suing company attacked his patent on the ground that the pointer was not Young's invention. Right, the court agreed; standing alone, the little controller did *(Continued on page 122)*



The United States Patent Office has granted a large number of patents to inventors whose changes, made on the original machine, were so trifling at times as to be practically invisible

The driller, right, has only his gages to tell him the revolutions of his drill, the weight on the hook, and pressure of the circulating mud

Here are two of the bits used by drillers. One is 27 inches across, the other five

Deepest Oil Well

Opens New Fields TWO

Clinging to a network of steel braces, men bolt together the pieces of one of the 200-foot derricks used in well-drilling

A LONELY wildcat well upon a hill overlooking the Pacific Ocean recently became the object of world-wide attention when its crew of brawny "roughnecks" pulled up the bit from the bottom of the hole and ran casing to a depth of 10,030 feet. A milestone had been reached, a record broken.

Penetrating the earth to a depth of almost two miles, this tiny hole, tapering to a diameter of only five inches at the bottom, became the deepest well in the world, surpassing the previous record by 390 feet.

At the same time it opened up alluring possibilities of vast new treasures of oil hidden in the deepest folds of the earth's crust, which may now be tapped by super-wells at hitherto undreamed-of depths.

This record well is the product of an industry whose methods, evolved through scientific development into a marvelous technique, would amaze the oil man of fifteen years ago.

Massive steel derricks, almost 200 feet high, now straddle the drilling platform, shouldering strings of drill pipe and casing weighing more than 100 tons.

Diesel engines and electric motors whirl rotary drills with incredible ease and smoothness.

Rapidly rotating bits, faced with steel of diamond hardness, eat into solid rock.

POWERFUL pumps, exerting tremendous pressures, force heavy liquid mud through four miles of pipe, circulating a fluid that brings cuttings to the top, at the same time softening and sealing the walls of the hole.

Ring-shaped bits mill their way through the rock, cutting circular specimens of the strata penetrated. Steel fingers clutch the core samples, protect them from injury, bring them to the top intact for examination.

Circular rubber washers, lubricated by water, spin around the revolving drill pipe, keeping the hole arrow-straight.

Tons of ice, forced under pressure into the hole, chill hot formations so that cement can be poured.

Huge electric pumps, of enormous lifting power, force oil from the depths, bringing flow when gas pressure fails.

The world's first 10,000-foot well, drilled near Seacliff, Calif., by the Chanslor-Canfield-Midway Oil Company, represents the latest step in a steady engineering progress before which successive records have fallen as the depth of commercial drilling has been extended from 2,000 feet sixteen years ago to 10,030 in 1931.

In 1915, at Charleston, S. C., a 2,000-foot well was sunk, striking a water-bearing sand yielding more than half a million gallons of very soft water per day, but no oil.

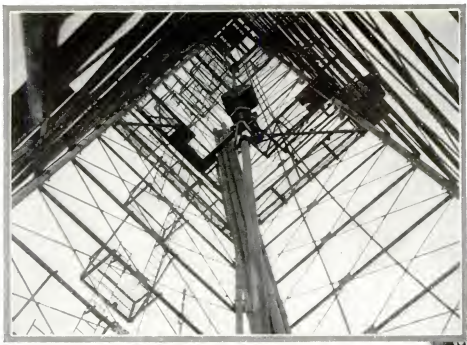
Within the next four years, all existing records were shattered by four wells located in various parts of the world. The deepest, drilled in northern West Virginia, reached a depth of more than 7,000 feet.

Meanwhile, miners also had been burrowing more deeply into the crust of the earth. In Michigan, the operators of the Tamarack mine sank their shaft No. 2 to the 5,200-foot level, and established what promised to be a permanent record. The increasing heat at this extreme depth, however, threatened to set a definite limit below which men were unable to work.

But oil men continued to thrust their tiny probes deeper and deeper in search of new fields of petroleum. In 1921, the Associated Oil Company's Butterworth No. 1, spouting oil from a depth of 4,682 feet, brought the famous Santa Fe Springs field into the spotlight.

Four years later, General Petroleum's Amestoy well at Rosecrans, Calif., brought a thin trickle of clean oil from 6,737 feet; in 1926, a new record was set by the Chanslor-Canfield-Midway well at Brea, Calif., down 8,000 feet.

AT THAT time, a mounting tide of prosperity brought millions of motor cars to American homes, creating a demand for vast quantities of gasoline. The search for new zones of production started a flurry of deep drilling that in California alone sent 149 wells down to the 8,000-foot level. Eight of these reached a depth of 9,000 feet. Amazingly rich production from old wells newly deepened lent impetus to the search. Geologists suddenly realized

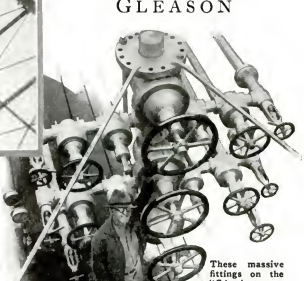


A modern steel derrick, seen looking up through it from below. The huge traveling block of pulleys, holding the tongs that grasp the casing, is plainly seen in center

This Article Tells How Man Has Defeated Nature and Drilled His Way to Hoards of Hidden Wealth

By
STERLING GLEASON

MILES DOWN



These massive fittings on the "Christmas Tree" restrain the upward pressure of the gas

that a 10,000-foot well was not a physical impossibility, and the race was on!

In the barren hills of central California, Standard's Mascot No. 1 shot down almost to the goal, but was halted at 9,650 feet, after having swallowed twenty-three bales of hay and a vast quantity of other material in a subterranean cavern that defied efforts of drillers to plug it.

A wildcat well drilled in the same region by the Shell Company soon surpassed the Mascot by more than fifty feet. Then, one day in May, 1931, a crew of C. C. M. O. Company's drillers hustled the bit down through streaky shale until the magic figures, 10,000 feet, were chalked up on the log, and a good thirty feet more to spare!

The goal had been reached. Geologists, triumphant, readjusted their sights and aimed at a new mark. Who now, they ask, will be first to reach the depth of 15,000 feet?

Between the present record and that new figure lies a whole mile of the hardest drilling yet experienced by modern oil men. Can that goal be reached, or are the obstacles too great?

THE answer lies in the hands of the engineer. Derricks must be designed that can hold tremendous weights while casing or drill-pipe is being run into the hole. Fifteen thousand feet of the tough, wiry pipe that twists the bit weighs 200 tons, and the casing is even heavier—a mighty load for a derrick to shoulder.

Engines must be built that can lift these great weights, yet turn the drill over a wide range of speeds, with velvet smoothness and an amazing nicety of control.

Pumps must be provided that can drive a stream of heavy mud down three miles into the earth and bring it to the surface again, laden with hard, abrasive cuttings that wear valves and fittings like emery dust.

CASING must be constructed of alloy-steel, heat-treated material so tough and strong that it can support its own dead weight of perhaps a half-million pounds when suspended in the hole. Joints and collars joining sections of this pipe must bear the brunt of this tremendous strain without ripping threads asunder. Cables of great tenacity must be drawn to support such loads. Cables on present wells last barely a week.

Fittings must be made that can withstand the pressure of gas pockets existing in these deep folds of the earth's crust—a force so great that blow-outs have sometimes formed huge craters deep enough to swallow derrick and all. Tons of rock exert unbelievable forces on these deep gas pockets, for in a 10,000-foot well, the mere weight of a column of water standing in the hole runs up a hydrostatic pressure of 4,330 pounds per square inch. The wear on fittings is tremendous. One well near Oklahoma City produced the astonishing quantity of 700 barrels of sand in fifty-five minutes, while yielding 2,284 barrels of oil and 50,000,000 cubic feet of gas daily.

The extreme heat, as the depth of drilling increases, is a problem that geologists fear may prove a difficult one as the three-mile mark is approached. In the hard coal mining industry, measurements have indicated that heat increases one degree in about fifty-five feet of depth.

One of the electric pumps used in deep well drilling. The two weights rotate in opposite directions. Above them is the traveling block

A well at Longmont, Calif., showed a temperature at only 6,500 feet of 210.3 degrees—just below the boiling point; while at Lost Soldier, Wyo., temperatures in shallow wells led experts to estimate the terrific heat of 537 degrees at 10,000 feet.

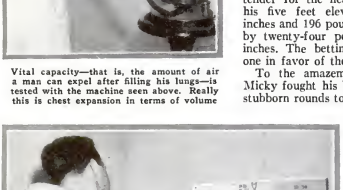
(Continued on page 135)

Blowing mercury up into the tube, below, tests a man's lung force. After thirty, this force slowly declines hut not as fast as the loss of muscular strength

Grip was measured by this device, a close-up of which is seen in circle

W*hy* Good Little Men *Beat* Good Big Men

Vital capacity—that is, the amount of air a man can expel after filling his lungs—is tested with the machine seen above. Really this is chest expansion in terms of volume



Pulling strength was determined with the use of this hand dynamometer, upon the dial of which the effort was registered. Short men of the 160-pound class had greatest pulling power

By JAMES NEVIN MILLER

FORTY thousand fight fans, packing Ebbets Field, Brooklyn, N. Y., some weeks ago, howled their hoarse approval as Mickey Walker, "toy bulldog" of the prize ring, worried Jack Sharkey, the heavyweight "Boston sailor."

Most of them were not betting on Mickey. The plucky one-time middleweight champion of the world was the sentimental favorite, but fight-wise gamblers were not risking their money. The toy bulldog was battling an Airedale. Mickey stood only five feet seven inches, and weighed but 172 pounds. Jack, contender for the heavyweight crown, with his five feet eleven and three-quarter inches and 196 pounds, had the advantage by twenty-four pounds and almost five inches. The betting odds were three to one in favor of the sailor.

To the amazement of the wiseacres, Micky fought his bigger opponent fifteen stubborn rounds to a draw. But then, the sports sharps are always surprised under such circumstances, as when Jack Dempsey beat the towering Jess Willard and Harry Greb, light-heavyweight, licked Gene Tunney, a head taller and fifteen pounds heavier.

Scientists of the U. S. Public Health Service recently solved some of these mysteries of big and little men. By tests they found out how bodily strength is influenced by size, build, and weight.

About 500 men, between twenty and thirty-four years of age, ranging from 120 to 169 pounds in weight and from five feet three inches to five feet ten inches in height, were subjected to the tests to determine their prowess in pulling, pushing, and lifting, the strength of their grip, and their lung power.

In the first group, the shortest and most sturdily built men were generally stronger than the tall ones. For example, those measuring from five feet three inches to five feet four inches, weighing 120 pounds, outclassed those who were from one to five inches taller.

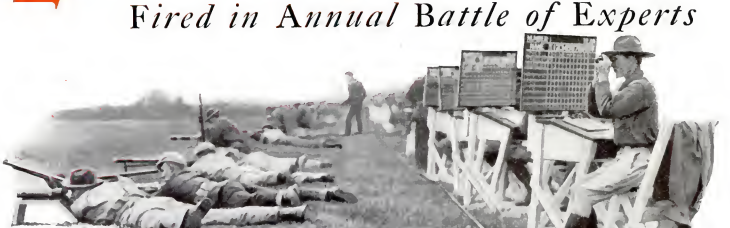
THE same held true of the second class, the fellows weighing from 130 to 139 pounds. In the third group, including those weighing from 140 to 149 pounds, the shortest men, five feet five inches to five feet six inches, also were the most powerful. Again, in the fifth, or heaviest class, those weighing from 160 to 169 pounds, the stockiest fellows, from five feet seven inches to five feet eight inches, registered greater strength than those who topped them by from one to four inches.

The fellows in the fourth group, tipping the scales at from 150 to 159 pounds, proved an exception to the rule. Here the tall men, from five feet nine inches to five feet ten inches, were stronger than those whose height ranged from five feet five inches to five feet eight inches.

The shortest men in the heaviest group had the greatest pulling power. As for pushing, the two heaviest classes were tied for honors. In these two classes, 150 to 159 pounds and 160 to 169 pounds, the men five feet nine inches to five feet ten inches made the pushing record—121 pounds. *(Continued on page 126)*

2,000,000 SHOTS

Fired in Annual Battle of Experts



At top, on the rifle range at Camp Perry. Targets are 600 yards away. In circle, police officer with sub-machine gun

Uncle Sam Boosts Scientific Gun Play as Marksmen Shoot It Out at Camp Perry

By ROY ELTON

TWO million winged messengers of death recently whizzed across acres of sunburned grass, tore through paper covered sheets of cloth, and lost themselves in the cool waters of Lake Erie.

They were the bullets fired in one of the greatest shooting events ever staged, the 1931 National Matches, held at the biggest rifle range in the country, Camp Perry, Ohio.

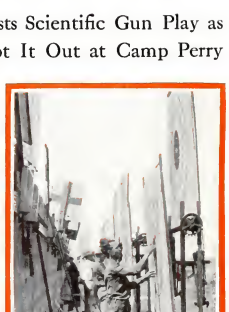
Nearly 4,000 men, women, boys, and girls, the pick of the country's marksmen, attended this great shooting contest, sponsored by the United States Government to promote skill with rifle and pistol.

Here, at least, was one place where the red-blooded citizen with a love of firearms inherited from pioneer ancestors, to whom a knowledge of guns was an absolute necessity, could get all the shooting he or she wanted.

During most of the year Camp Perry consists of little more than a group of white wooden buildings, a number of Ohio National Guard tents, and a flagpole. When the middle of August rolls around, a city of tents springs up almost overnight. These tents, provided by the Army, are used by contestants as living quarters during the matches.

Squaw Camp, one section of the tent city, is assigned to women contestants, children, and married couples. The pistol, rifle, and machine gun ranges extend for two miles along the lake shore, bullets being directed towards the water of Lake Erie. There are 100 pistol targets at various ranges, ninety-two rifle targets at 200 yards, ninety-seven at 600 yards, fifty at 800 yards, and 110 at 1,000 yards.

There is a small-bore range with 120



The rifle butts and the targets at the Camp Perry range. Note that the targets can be lowered to check hits and paste black or white patches over the holes between shots

Roger Hughes, 11, Youngstown, Ohio, is one of the youngest marksmen shooting in the Junior School of the camp

targets, an indoor range, a running-deer range presided over by Colonel A. B. Critchfield, "discoverer" of Camp Perry; a special police pistol range having running and disappearing men targets, and an international 300-meter range. It requires the services of 3,000 soldiers to run Camp Perry during the matches. They maintain the communication system, operate targets, handle traffic, and do hundreds of other necessary things.

Civilians and the best shots from the Army, Navy, Marine Corps, National Guard, and various police departments participate in matches that are sponsored jointly by the National Rifle Association and the United States Government. There are nearly 20,000 entries in all matches each year. Of course, most shooters enter several contests.

THE first week is devoted to school activities. While boys and girls are being taught how to hold and shoot small bore rifles at one end of the firing line, at the other end officers from New Orleans, Portland, Ore., Los Angeles, Washington, and elsewhere are being taught how to use and protect themselves against gas in combating criminals. In between, there is almost everything to be found in the field of shooting, and a lot of activities that are not strictly matters of gun-handling.

The enthusiasm of young people in the instruction groups and on the firing line is almost unbounded. Girls in pajamas, shorts, overalls, demonstrate that the male contestants are not the only ones capable of handling firearms. It is not unusual to see a girl hardly big enough to hold a gun standing in the firing line between a grizzled Army sergeant and a prominent surgeon or attorney, and not infrequently beating them both to a marked degree.

Culminating the young people's activities are several matches. Two of the most hotly-contested are the Whistler Boy trophy matches, one in the fifteen-eighteen-year class, and the other for entrants under fifteen years. The two trophies were presented by G. A. Hughes, of Youngstown, Ohio.

At the last meet, to keep the trophies in the family, Robert Hughes, in the fifteen-eighteen-year class, won with a score of 389 out of a possible 400; while his brother Roger, eleven, one of the youngest contestants, took the companion trophy with a 375 out of a possible perfect score of 400.

The police school, supervised largely by

This eight-foot rifle was taken to the Camp Perry meet by a Tennessee mountaineer and used by him in the matches

On the Camp Perry pistol range, police, military men, and civilians meet to demonstrate their skill

Below, a new Army anti-aircraft gun shown in action at Camp Perry

Above, police at the national matches received instruction in the proper method of taking guns from crooks

Army experts in the various forms of combat and protection, includes instruction in disarming, pistol shooting, riot-gun work, chemical warfare, sub-machine gun use, ballistics, firing at automobiles, and "Hogan's Alley."

Hogan's Alley was created at the request of police officials who wanted to give their men training in handling criminals who take refuge in buildings. The Alley consists of a series of building fronts, much like the sets of a movie lot. There is a pool room, a hotel, and other features of a typical slum.

Life-size figures of men suddenly appear, unannounced, behind chimneys, in windows and doorways, and around the corners of buildings. It is up to the officer to grab his revolver and hit the target before it disappears, a matter of three seconds or so. Concluding the school period, a Hogan's Alley contest is held.

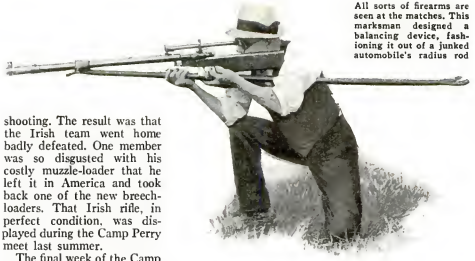
The ninety National Rifle Association matches are held during the second week of the shooting. Three of these are outstanding because of the trophies awarded. One, the President's Match, draws each year the largest number of contestants because it is the richest in rewards. Besides a service rifle presented by the Ordnance Department, and numerous cash prizes and medals, a letter from the President of the United States to the winner is included in the list of awards.

One of the oldest of all American trophies, the Wimbledon Cup, is the prize awarded the rifleman who makes the best score in firing twenty shots at 1,000 yards with a .30 caliber service rifle. The cup, presented in 1875 by Queen Victoria of England for competition by American riflemen, has lost some of its interest since the dawn of prohibition. Inside the cup is a vertical line of silver pegs. In other days, when the trophy could be filled with champagne, a marksman who lowered the contents one peg had quaffed an even pint.

THE Leech Cup, awarded in a match fired with a .30 caliber service rifle at 800, 900, and 1,000 yards, is much like the Wimbledon Cup in appearance, except that it is minus the wine pegs. It was presented in 1874 by Captain Arthur Blennerhassett Leech, an Irish officer and an ardent rifleman.

In fact, Captain Leech, later Sir Arthur Leech, may be considered the real father of the American National Rifle matches. His team of Irish shooters, using carefully made muzzle-loading rifles, had defeated every other team in Great Britain and Europe, and turned to America for new fields to conquer.

As a result of a request made by Captain Leech to the New York *Times*, an American-Irish match was arranged. The American team employed breech-loading rifles, then something new in contest



All sorts of firearms are seen at the matches. This marksman designed a balancing device, fashioning it out of a junked automobile's radius rod

shooting. The result was that the Irish team went home badly defeated. One member was so disgusted with his costly muzzle-loader that he left it in America and took back one of the new breech-loaders. That Irish rifle, in perfect condition, was displayed during the Camp Perry meet last summer.

The final week of the Camp Perry period is devoted to the real National Matches, those held as a result of an act passed by Congress in 1902. There are four main events, covering group and individual firing with rifle and pistol. These draw the greatest number of contestants of any in the entire meet.

Guns are literally everywhere in Camp Perry during the matches. The Government issues 2,000 .30 caliber service rifles, twenty service rifles with a .22 caliber bore, and 400 automatic pistols, .45 caliber, to entrants, and provides all ammunition.

But the service rifles, caliber .30, are vastly different in some respects from those used by the typical doughboy, marine, or gob. They are a special lot, made with the utmost care. Working parts are hand finished, and the barrel is carefully gaged throughout every inch of the bore before the rifle is accepted.

In the 1931 match, special National Match ammunition used in former years was not specified. Instead, contestants were issued cartridges having a 172-grain boat-tail bullet with a jacket of copper alloy that does not foul the inside of the rifle barrel. The muzzle velocity of the bullet is 2,700 feet per second.

THESE special rifles and ammunition represent the last word in high power rifle accuracy. Under ideal conditions they will shoot straight enough to hit a figure the size of a man virtually every time at a distance of 1,000 yards. In spite of this superb accuracy, however, long range rifle shooting is a supreme test of knowledge and experience as well as a mere test of rifle pointing accuracy.

The winners of all long range matches held on days when there is any wind blowing, and that means nearly every day at Camp Perry, are the fellows who can most accurately gage the effect of the wind on the bullet. This effect is so great at one thousand yards that a stiff cross wind may carry the bullet so far to one side that it may hit the next target in the row, and the targets, at this range, are ten feet wide.

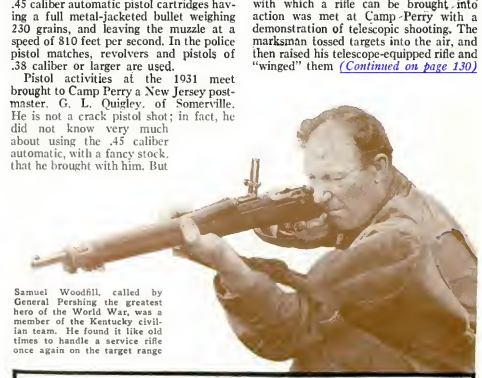
The beginner, no matter how accurately he can sight or how steadily he can hold, is lost in these long range matches until he has acquired the cunning of an Indian in reading the velocity and direction of the wind from the waving of the grass, the drifting of smoke, and the appearance of the heat waves.

The automatic pistols issued are like those carried by service men. They employ .45 caliber automatic pistol cartridges having a full metal-jacketed bullet weighing 230 grains, and leaving the muzzle at a speed of 810 feet per second. In the police pistol matches, revolvers and pistols of .38 caliber or larger are used.

Pistol activities at the 1931 meet brought to Camp Perry a New Jersey postmaster. G. L. Quigley, of Somerville. He is not a crack pistol shot; in fact, he did not know very much about using the .45 caliber automatic, with a fancy stock, that he brought with him. But he had heard that robbers sometimes attempt to steal valuable mail, and he determined to be ready for them. So he went to Camp Perry to attend the pistol school and learn how to defend Uncle Sam's mails.

It is in the .22 caliber group that the greatest variety in firearms is found. In most cases the small-bore rifles, costing anywhere from $50 to $200, are more carefully made than the larger service guns. Specially made barrels, improved stocks, intricate sights, and a number of other features distinguish these rifles, and incidentally run the price up. About 300 small-bore rifles were registered in the 1931 meet.

In the "any-sight" matches, rifles with telescopes mounted in place of the usual metal sights are seen. Telescopic sights are coming into greater use for almost every kind of shooting. The objection of some that such a sight decreases the speed with which a rifle can be brought into action was met at Camp Perry with a demonstration of telescopic shooting. The marksman tossed targets into the air, and then raised his telescope-equipped rifle and "winged" them *(Continued on page 130)*



Samuel Woodfill, called by General Pershing the greatest hero of the World War, was a member of the Kentucky civilian team. He found it like old times to handle a service rifle once again on the target range

A Camp Perry instructor initiates a group of girls into the mysteries of properly handling a rifle

STEAM TURBINE TO RUN NEW AIRPLANE

Capt. H. C. Richardson with a model of his steam-driven airplane now being built at Cleveland. At right, note turbines behind the propellers

BEHIND the closed doors of a one-story brick building at Cleveland, Ohio, plans have just been completed for an amazing 2,500-horsepower airplane to be driven by steam. At this writing its construction was about to begin. No fanciful project is this, for it is sponsored by one of the country's leading makers of aircraft. Navy officials interested in the plane's military possibilities will take charge of the first tests when it is completed soon. This marks the first serious attempt to apply steam power to a plane since Samuel Pierpont Langley's ill-fated "aerodrome" dove into the Potomac River in 1903. When the unreliability of steam power plants doomed early airplanes to failure, inventors turned to internal combustion engines to drive their flying machines. Modern lightweight alloys, unknown in Langley's time, have made possible a radical new type of steam turbine not too heavy for a plane, according to engineers of the Great Lakes Aircraft Corporation, who are building the latest craft. They have high hopes that return to steam power may lead to a revolution in airplane design, both for military airplanes and huge commercial transport planes. Chief among the advantages of a 2,500-horsepower steam-driven plane would be the enormous load of passengers or freight that it could carry. Absence of noise, vibration, and fire hazard are others. Steam heat from the turbines may be used to make the passenger cabin comfortable in winter. Far from a dreamer is the designer of the aerial locomotive—Capt. Holden C. Richardson, U.S.N., retired. He has served as chief engineer of the Naval Aircraft Factory and as head of the Design Branch of the Naval Bureau of Aeronautics. He designed the Navy's famous NC seaplanes that crossed the Atlantic in 1919, piloting one of them on the flight himself. As technical adviser to the Cleveland concern, he convinced its officials that a practical steam airplane could now be built. To POPULAR SCIENCE MONTHLY he has revealed some of the striking details of the craft now projected. Outwardly the steam airplane reveals little of its unusual construction. Its lines are patterned for the most part after present-day planes. But within the fuselage is a boiler where the steam is generated. The fuel will not be shovelfuls of coal, such as popular imagination might connect with a steam power plant, but oil of a cheap and economical grade. Steam from the boiler will run two high-speed turbines on the wings, one behind each propeller, and will then pass through condensers between the turbines and the fuselage. Since the recovered water is used over again, only thirty-eight gallons are required. Oil and water are supplied to the boiler automatically; no "aerial fireman" is needed. The pilot controls the plane's speed simply by operating one throttle for each turbine.

DISTANT MINE FIRED BY GERMAN "DEATH RAY"

FAVORITE among the projects of war-device inventors is a "death ray" that will kill enemies at a distance. Fortunately, perhaps, the few who have claimed any progress toward such a ray have tested it harmlessly by stopping automobile motors or setting off explosive charges at a safe distance. Latest of these is Kurt Schimkus, a chemist of Berlin, Germany. With the apparatus pictured above he succeeded recently in exploding a mine two hundred yards away at Lake Constance, Germany.

HEART SHAPED CARDS

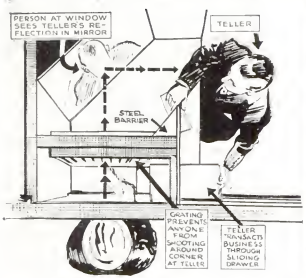
EASIER to shuffle and deal, according to the maker, are these heart shaped playing cards. Another advantage over the regulation style is that a greater number of them may be held in the hand at once. Numbers appear on the two lobes.

FASTEST ELECTRIC CAR ON PHILADELPHIA ROAD

WHAT is declared to be the fastest electric car in the world has been designed for a thirteen-and-one-half-mile suburban railroad between Philadelphia and Norristown, Pa. It is expected to develop a top speed of between eighty and one hundred miles an hour. Ten of the streamlined aluminum cars will soon be placed in passenger service. The fishlike shape, which reduces wind resistance at more than mile-a-minute speeds, was given hundreds of wind tunnel tests in the University of Michigan's aeronautical testing laboratory before the final design for actual service was chosen. Each car carries fifty-two passengers.

World's fastest electric car, streamlined to reduce wind resistance to the minimum, which will soon be put in operation on a short road leading out of Philadelphia

Mirror Hides Bank Teller to Thwart the Holdup Man



AN OPTICAL illusion would put an end to bank holdups, in a remarkable teller's cage devised by a Long Beach, Calif., inventor. When a bandit, posing as a customer, approaches the teller's window he thinks that he sees the teller behind it. Actually, however, he is looking in a slanting mirror, and the teller is standing out of the way at the side. He transacts all business through a sliding drawer. Should the bandit threaten the image with a gun, the teller, in the flesh, merely steps into a gun turret beside the window and covers the intruder until police seize him. Even if the robber should fire, the worst damage that his bullet could do would be to shatter the mirror. Wide bars and a steel wall protect the teller from anyone who might know the trick. The inventor, David G. Earl, has constructed a full sized working model of his teller's cage to demonstrate its possibilities.

PENCIL IS REAL GUN

THIS pocket pencil may be converted in a flash into a deadly weapon. Its barrel shoots real bullets. A knob on the side serves as a trigger, and cartridges are inserted by opening the center part of the pencil. Designed by a German manufacturer, it is so constructed that it cannot be fired accidentally.

RADIO CONTROLLED GATE GUARDS HOME

A WEALTHY oil man has just installed a pair of radio-controlled gates to bar intruders from his estate near Brea, Calif. A visitor announces himself by means of a telephone on the gatepost. An occupant of the house presses a button, and the massive gate unlocks itself and swings open under the impulse of a hidden motor. Cars used by members of the family are equipped with radio transmitters that will open the gate. Thus they may drive in without stopping, merely touching a dashboard button to start the gate motor. The pair of gates are said to cost $10,000 to install.

Weighted reins on pulley blocks are used in this German created school for would-be horsemen. Correct posture and grip are thus taught without the use of real horses

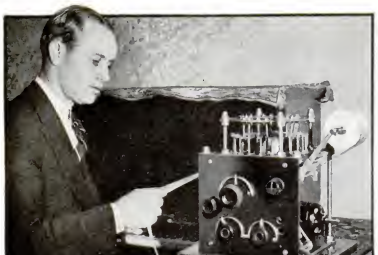
NIGHT PLANES NOW FLY ACROSS THE CONTINENT

TRI-MOTORED planes now fly at night to carry passengers and mail between New York and Chicago. The new service puts the entire transcontinental route between New York and San Francisco on a twenty-four-hour-a-day operating basis, made possible by the installation of hundreds of flashing beacons along the way.

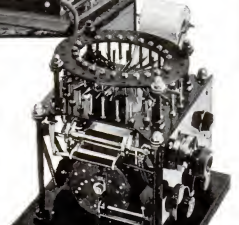
HORSEMANSHIP TAUGHT WITHOUT USING HORSE

WOULD-BE horsemen and drivers learn the tricks of handling the reins upon wooden dummies, at a unique school of horsemanship just opened at Ruhleben, Germany. It provides classes both for equestrians who ride for sport and for teamsters and tradesmen who drive grocery and milk wagons. The pupils hold "reins" that consist of weighted ropes passing over pulley blocks, while a teacher criticizes them. Instruction is also given in correct posture while seated on a horse. Both men and women attend the school.

Machine Writes Music as Composer Plays It



Gates E. Underwood with music writing machine he invented. Below, view of machine with paper roll in place ready to record notes



A BOON to amateur and professional composers is a robot music writer invented by a young San Francisco mechanic. Merely play a tune through upon the piano and paper tape unrolls from this remarkable machine with both melody and harmony printed upon it in standard musical notation. The tape is gummed on its reverse side, and may be cut to any desired lengths and pasted on paper of suitable size for use. Hours of tedious copying with pen and ink are thus eliminated. The automatic music writer is the first of its kind that may be attached to an ordinary piano. The nearest light socket supplies current to run it, and installation takes but half an hour. A bank of electric switches placed over the action of the piano operates the printing type on the machine through electromagnets. As each note is struck, a musical character is electrically registered on the moving tape, in the proper line of the musical staff. The machine never makes a mistake, and can keep up with the most rapid pianist. Automatic devices faithfully record the rhythm of a passage and the length of each note.

Switching a dial sets the machine to record a tune in any desired key, since it transposes automatically. The inventor, Gates E. Underwood, took three years to perfect the music writer, building the original model by hand in his own kitchen. He says that the machine is noiseless and can be operated by anyone with a few minutes instruction.

LITTLE BOY JUMPS 40 FEET WITH BALLOON

LONG popular in Europe, the thrilling sport of balloon jumping has recently gained followers in this country, and probably the youngest of them is four-year-old Billy Crawford, of Cleveland, Ohio. Sitting in a harness below a diminutive balloon, with its buoyancy regulated until it is just one pound less than his own weight, he can make leaps forty and fifty feet high. A tether is attached to his jumping balloon for safety. Older balloon jumpers, using untethered balloons, are able to leap prodigious distances across country, and jump over houses and trees much as if they were wearing seven-league boots.

NEW MACHINE FOR HOME TURNS WHEAT TO BREAD

SOON the housewife may ask her grocer for a bushel of wheat instead of a loaf of bread, since an Italian inventor has perfected a machine that turns grain directly into bread in the home. It is operated by gas, electricity, or water power. When a supply of grain is poured in, the device grinds it to flour, rejects any husks, mixes the flour with other ingredients for bread, allows the dough to rise, and finally bakes it in an automatic oven. The machine would be made in various sizes for household or hotel use. According to the inventor, this direct method would eliminate wasteful steps in present-day production, such as shipping the grain to a mill to be ground and thence to bakeries and retail stores, the cost of which is borne by the ultimate bread consumer.

TINY MINE MODEL PREDICTS DISASTER

TINY models of abandoned mines only 1/3,000th actual size warn miners of the deadly peril of a cave-in when the models are whirled in a remarkable machine just invented by Prof. Philip B. Bucky, of Columbia University. Engineers hail his device as a brilliant stroke of inventive genius, since it permits tests never possible before. Hitherto many lives have been lost in caveins when the supporting pillars of a used-up mine have been withdrawn, for mathematical calculation of the possibility of a collapse is involved and inaccurate. A model of a mine placed in Professor Bucky's machine is subjected by centrifugal force to the same strains as occur in practice. Through a window, an observer can actually watch the model break up and measure the forces with such accuracy as to warn the owners of the mine if it is dangerous. Other invaluable tests may be made with the spinning tester upon airplane frames, to guard against their collapse in flight, and upon steel plates for ships and girders for bridges.

Philip B. Bucky, of Columbia University, demonstrates his new invention which predicts the possibility of a mine disaster

Air Propelled Motorboat Carries Eleven Passengers

AIR-PROPELLED motorboats carrying up to eleven passengers have made their appearance in England, where they are known as "hydrogliders." Absence of the conventional propeller makes it possible for the boats to navigate extremely shallow waters. The four-bladed air propellers are driven by 140-horsepower rotary engines similar to those of airplanes and drive the craft at forty-five-mile-an-hour speed. The air-cooled engine is installed in a streamlined mounting at the after end of the hull.

USE X-RAY ON FLOWER

X-RAYS of blooming flowers provide unusual and artistic camera studies for a Des Moines, Iowa, woman who has developed the technique. Only a minute dosage of the rays is required to penetrate the fragile petals. The result is a picture of striking delicacy and beauty. One of her compositions, reproduced above, shows an Easter lily in bloom.

NEW FIRE EXTINGUISHER COVERS WIDE AREA

NUMEROUS small nozzles in a building's fire extinguishing sprinkler system are not needed in a new design recently demonstrated before the fire officials of Philadelphia. It consists of one large overhead sprinkler that is revolved by the force of the water and throws streams that will cover many hundred square feet. There are various forms of nozzles that can be connected with the main system. These are capable of throwing the water in a revolving spray or in a steady stream. It is designed for use in big office buildings and factories.

COPIES LETTER WITHOUT CARBON PAPER

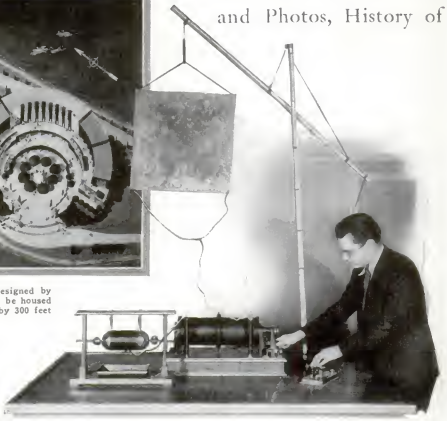
JUST placed upon the market, an ingenious new device permits a typist to make inked copies of a letter without the use of carbon paper. It consists of a metal frame with notched ends, holding a replaceable ribbon. Two sheets of paper are inserted in the typewriter and the frame is then dropped upon the platen with the ribbon between them, as shown in the photograph. The typewriter's paper guide, lowered upon the notches, keeps the duplicator from turning. In this way duplicates are obtained without the muss and smudge of carbon sheets. Either black or two-color ribbons may be used in the duplicator, giving a copy always identical with the original. Replacement ribbons have metal tips for clean handling. An attachment enables more than one copy to be made at one time.

Above, a new fire sprinkler that has a revolving nozzle that will throw water over a wide area. At left, a variety of nozzle attachments that can be used with this system to throw revolving spray or direct stream at indicated point

How WIRELESS *Grew*

Exhibit at World's Fair and Photos, History of

In one of the buildings of this electrical group, designed by Raymond Hood, of New York, the radio exhibit will be housed during the coming World's Fair. It will be 1,200 by 300 feet



Shown above is an exact reproduction of the apparatus used by Marconi to send his first messages long before his attempt at transatlantic wireless. The original was burned. Note the old-fashioned spark coil hooked to the metal-plate antenna

Marconi made his first experiments in exchanging messages with ships at sea from this shack at Babylon, L. I. It will be carried bodily to Chicago and made part of the radio show. Picture above shows it with Edwin H. Armstrong, radio pioneer who helped find and identify the shack that for years had been regarded as merely an ordinary tumble-down little building. Marconi's experiments made here marked the beginning of the period that has seen hundreds of lives saved through the use of the wireless when accidents have disabled ships at sea and near-by vessels, picking up the SOS, have rushed to the rescue

At left, a rare old photo showing the inside of the Marconi station at Babylon and the instruments he then used. Below, when Marconi made his first transatlantic wireless tests, he used kites as aerials, one of which is seen here held by G. S. Kemp, who assisted in the early radio experiments

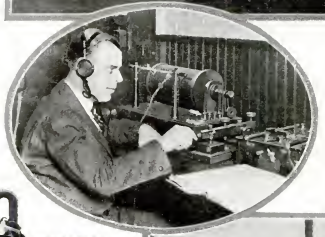
At left, Edwin H. Armstrong's first superheterodyne set which, when it appeared, was hailed as the last word in radio development. Its circuit forms the basis of most of the latest sets

to World *Circling* Radio

Will Tell, in Instruments This Miracle of the Age

WHEN the World's Fair opens in Chicago, in 1933, there will be a unique exhibit depicting the history of radio supplied by an Eastern firm which has a museum of historic instruments and photographs. In such scenes as those on these pages, many of which are taken from the museum, it will relive the romantic history of Marconi's pioneer work, the golden days when broadcasting was young, and reminiscences of the key-pounders of twenty years ago. The amazing story of the evolution of wireless into the present world circling radio, that speaks through the air to the people of all nations, will be clearly shown in the unique exhibit. It is expected that following the close of the World Fair, plans will be made to find a permanent home for the radio museum, probably somewhere in the East, where it can be open to the public at all times. It would thus become a lasting memorial to the memory of the men who perfected the means of using the Hertzian waves as well as those who have faced death to send out the SOS appeals from sinking ships.

On the twelfth of December, 1901, the picture above was taken of Guglielmo Marconi in his Newfoundland operating room, after listening to the first transatlantic message from Cornwall, England



At left, Jack Binns, hero of the ill-fated *Republic*, who sent out the call that led to the first wireless sea rescue. He is seen in photo operating a set of vintage of 1903

In 1904, long before broadcasting came into fashion, receiving sets like this one built by Walter Massie were the latest things in radio

During June, 1915, Charles E. Apgar, above, made phonograph records of all messages sent out from Sayville, Long Island, and sent them to U. S. Secret Service men. As a result a German spy station, WSL, was raided and closed

At left, KDKA of East Pittsburgh, which on Nov. 2, 1920, sent out the first prescheduled broadcast ever given for public reception. This ushered in modern programs of music, sketches, and lectures

EGG SHELL CARTOON IS NEW FAD

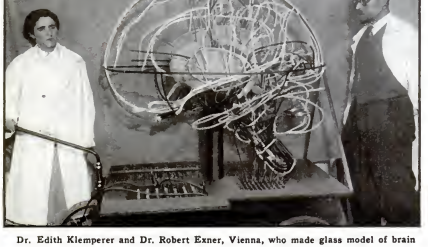
Graham Dale, New York artist, and photos of the egg-shell cartoons he makes of noted persons. At right is Alfred E. Smith

In circle, Mae Murray. Above, left, Thomas A. Edison; and, right, Max Schmeling, pugilist

How would you like an egg-a-toon of yourself? It's a new form of cartoon, the main ingredient of which is the shell of an egg. Graham Dale, New York City artist, created the fad. He takes an egg, blows out the insides, draws a face on the shell, paints on flesh color, adds hair and realistic dabs like wrinkles and eyeglasses, mounts the shell on a base—and there you are, natural as life. Egg-a-toons are now being used as favors. Dale says that men and women in all parts of the country have sent him their photos, requesting egg-a-toons of themselves.

TEN-MILE FLYER PLANS TWENTY-MILE ASCENT

A BALLOON voyage to a height of 100,000 feet, or nearly twenty miles above the earth, is the daring venture now planned by Charles Kipfer. He and Prof. Auguste Piccard, Swiss physicist, sailed almost ten miles up in a sealed metal ball, hung from a balloon, a few months ago (P. S. M., Aug. '31, p. 23). That record has just been confirmed by international authorities who announce that the two adventurers reached an altitude of 51,775 feet.



Dr. Edith Klemperer and Dr. Robert Exner, Vienna, who made glass model of brain

ELECTRIC RAIN GUN SPRAYS FRUIT TREES

NO LONGER need trees in an orchard parch during a drought. A Berlin inventor recently turned out an electrical "rain gun" that is said to water trees as naturally and effectively as a natural shower. It is powered by a motor-driven pump. So constructed is the nozzle that the water, thrown a long way, falls upon the trees in a gentle spray, with just sufficient force to wash the leaves as real rain would do, and without striking hard enough to injure the fruit or sweep it from the branches. The apparatus is mounted on wheels for portability.

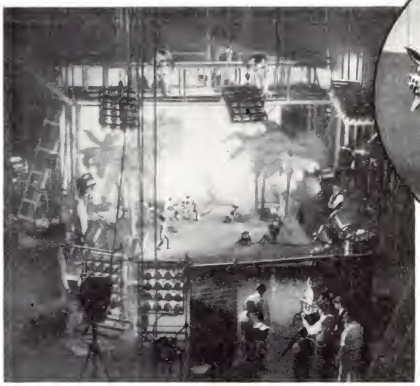
MAKE SEESAW FROM AIRPLANE WHEELS

WHEN these old type airplane wheels were discarded, British youngsters seized them and persuaded father to clamp them together on an improvised axle. A plank slid between the two wheels provided them with a homemade seesaw.

USE GLASS IN MODEL OF BRAIN

STUDYING the brain structure without performing an autopsy is made easy for medical students by an electric-lighted model in which intricate details of the brain can be seen. Two Vienna scientists, Dr. Edith Klemperer and Dr. Robert Exner, have just completed it after years of research. It is made entirely of glass, hundreds of tubes being manipulated into the form of the brain parts, stained in conformity with the colors used in medical books. By using glass it was possible to build a practically transparent model, facilitating the study of the inside of the brain.

DUMMIES REPLACE ACTORS IN GERMAN TALKING PICTURE



Making a talkie with marionettes as actors. Note men working strings

One of the dummies astride a weird monster that was seen in the German-made talking picture in which puppets were used exclusively in place of actors. Men in gallery pulled the busy strings

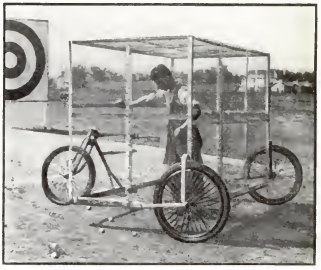
MARIONETTES took the place of actors in an unusual talking movie produced in Germany recently. A special stage was built for the purpose, with an overhead gallery from which the puppets were manipulated with strings. The figures used were about half the size of human beings. Sounds and voices were later added to the film to make an ultra-modern version of a puppet show.

SPONGE RUBBER USED TO KEEP ROAD SMOOTH

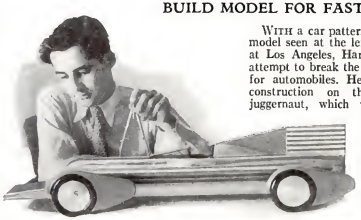
MORE comfort for the motorist may result from a new sponge rubber expansion joint for pavements, invented by an Akron, Ohio, engineer. At present asphalt or tar fillers are used in concrete pavement joints to allow for expansion and contraction of the pavement caused by temperature changes. In hot weather, this filler may be forced out, causing bumps, resulting in cracked or broken pavement. Thompson's invention consists of a strip of sponge rubber placed in the joint and held in place by cement. When the concrete contracts the rubber expands, and when the joint becomes smaller, the rubber is compressed without bulging up to form a ridge. The new joints have been successfully tested on a road near Akron.

CAGE ON BICYCLE GUARDS CADDIE

HARD-DRIVEN golf balls, though they make frequent dents in the wooden target, have no terror for the boys who pick them up on this driving range. They work within a "cage bicycle," consisting of a light mesh-covered frame with three motorcycle wheels. The front wheel's steering bar extends inside the frame, so that it may be manipulated without exposing the body. The front of the shield is open. Two or three boys usually work inside, picking up balls in long-handled wire dippers. The cage is shown in use in the photo at right.



BUILD MODEL FOR FASTEST AUTO

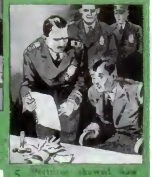


WITH a car patterned exactly after the model seen at the left, recently exhibited at Los Angeles, Harry Fengler plans an attempt to break the world's speed record for automobiles. He has already begun construction on the 3,000-horsepower juggernaut, which will be named the *America I*. It will have two engines and a four-wheel drive. Success would regain from England the mark of 247 miles an hour, set by Sir Malcolm Campbell last spring.

Microscope

Solve Murder Mysteries with

Ferdinand Watzek of Vienna, one of the expert microscope crime detectives of Europe



GUST-driven rain was lashing the big elms in front of the country house in the New Jersey hills on the night David Winter was murdered. That fact, by a curious chain of circumstances, led to the single, astonishing, microscopic discovery that sent his slayer to the electric chair.

In the house at the time of the crime were a twenty-year-old nephew, the housekeeper, and a chauffeur who had been in the employ of the wealthy widower for many years. All declared they had retired early, leaving the old man going over his accounts by the fire. They had heard no unusual sounds during the night. Yet, the next morning, the housekeeper found the body of her employer slumped in his cretonne-covered armchair, his skull crushed by a blow from a bloodstained hammer that had been dropped beside him.

Taking charge of the case, a scientific detective examined the hammer handle. At a point where the first finger of a gripping right hand would come, he discovered a smear of dried blood. He studied it through a magnifying glass. There were no fingerprints. The murderer had worn gloves.

He demanded to see all gloves in the house. The chauffeur explained that his had been ruined the day before by acid spilling from the auto battery. Leading the way to the garage, he pointed out a pile of rags where he had thrown them. The detective rummaged in the pile, found the right glove, carried it to the light. His eyes narrowed. The entire tip of the first finger was eaten away with acid!

Apparently balked by this clever ruse, he raced to his laboratory with the glove and the hammer. There with a powerful compound microscope, he set to work. In three minutes, he had discovered an extraordinary thing, and in less than an hour, he held in his hands two dripping films, photomicrographs which solved the mystery of the murder and brought the killer to justice.

One film showed a magnified picture of a tiny elliptical spot where the wood grain lay bare on the hammer handle. The cutter on the lathe had missed this spot due to a depression in the stock from which the handle was turned. The other film showed a similar ellipse packed with wavy lines, the magnified picture of an impression stamped into the palm of the glove when the slayer gripped his murderous weapon. The chance fact that it had rained and his gloves were damp made the impression, when seen under the microscope, abnormally clear. Placed on top of each other, the pictures matched like two prints from a single film.

LATER, the guilty chauffeur confessed that his employer had discovered thefts extending over several years and had threatened to turn him over to the police unless he made restitution. Planning his crime so there would be no noise, he had crept up behind his victim, while the storm howled outside, and had killed him with a single blow. By using acid to eat away the one stain on the finger of the glove, he thought he had destroyed all visible evidence of his guilt. He had. But invisible evidence, revealed by the magic of the microscope, tripped him up and brought a quick conclusion to his "perfect crime."

THE details of this remarkable case were told me by a crack homicide sleuth at the Scientific Crime Detection Laboratory, in Chicago. In talking to detectives using science to trap criminals in more than a dozen American cities, I heard of scores of similar drama-packed instances in which microscopes solved baffling mysteries through clues too small to see.

I was told of dangerous killers caught through telltale specks of dust and metal; of master forgers exposed by microscopic canyons in the dried ink of ancient writing; of clever cracksmen run to earth by scratches on metal one ten thousandth of

Dr. Muehlberger, of the Chicago Crime Detection Laboratory, who has helped solve many crimes by studying clues too small to be seen

Detectives

Aid of Clues too Small to See

By
EDWIN W. TEALE

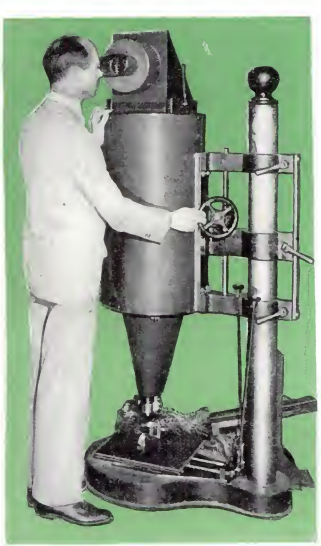
an inch wide; of desperate gunmen jailed through the mute testimony of a minute raveling of thread!

When the Sherlock Holmes of today wipes the lens of his microscope, he is rubbing the Aladdin's Lamp of criminology. In almost every realm of crime detection, it plays its part. It scrutinizes dust and hair and fibers. It reveals spurious gems and counterfeit coins. It makes the scientific study of handwriting, typing, and printing possible. Fingerprinting depends upon it. And the amazing story of forensic ballistics, the study of markings left on fired bullets, could never have been written without its aid.

To help the work of the microscope sleuth, new equipment is constantly being devised. For night investigations, a Detroit concern is marketing a combined flashlight and magnifying glass and a New York manufacturer has developed a glass ringed with small electric bulbs. Powerful folding microscopes are available for field work; comparison instruments, with double lenses showing two objects overlapping for special study, are made in many sizes; and compound instruments that give 1,200 magnifications have been designed in compact form for use in makeshift laboratories. The tools of the trade now range from pocket glasses, smaller than a quarter, to a colossal apparatus, tall as a man and weighing half a ton.

A flashlight attached to magnifying glass for use in the darkness in the search for invisible clues

This giant of the laboratory was devised by Luke S. May, famous in the Northwest as a scientific solver of mysterious crimes. It enlarges an object 5,000 times. When you visit May's laboratory in Seattle, Wash., and peer through the polished glass of this immense "magnascope," you see a human hair looking like a telephone pole, a speck of dust looming up like a massive boulder, and the finest stroke of a steel pen stretching like a wide black ribbon on a white background.



Luke S. May, famous in the Northwest as a scientific solver of mysterious crimes, devised a magnascope that enlarges an object 5,000 times, revealing tiny clues

It was this "magnascope" that figured prominently in a strange bit of scientific crime detection a couple of years ago. On a lonely road near Tacoma, Wash., a nine-year-old child was found brutally murdered. The slayer had hidden in a blind which he constructed of branches cut from trees with his pocketknife. Police rounded up suspects.

TAKING their pocketknives, May carried them to his laboratory. One after the other, he clamped them in an elaborate mechanical arm which sliced the blades through branches at the exact angle at which one of the limbs used in the blind had been cut. The results, enlarged 5,000 times by the "magnascope," showed that one knife left identical marks on the wood. In addition, the giant lens of the laboratory revealed that the tiny tip of a fir needle, found on the clothes of the owner of the knife, exactly matched the remaining part of the needle found at the scene of the murder! A quick conviction followed.

Even more spectacular was another feat of this famous microscope-using criminologist—his brilliant work, a few years ago, in connection with the "Mystery of the Thirteen Matches."

A little after one o'clock in the morning, the wife of an Idaho mine official sat up in bed frozen with fear. She had been awakened by the stealthy creaking of a door. It was pitch dark. Her husband had been called away and she was alone in the house. She heard the intruder feel his way across an outer room and fumble in a cabinet where $600 had been hidden for deposit the following day. Then at the top of her voice she screamed.

THE frightened burglar, the money in one hand, blundered toward the window, mistaking it for the door. Then he struck a match, got his bearings, and rushed into the night before neighbors could arrive. The woman had not seen his face. The county sheriff, unable to find a single clue, gave up the case as incapable of solution. Then Luke S. May was called in. His first question was:

"Where did he strike the match?"

"There, by the window," he was told.

Everything had been left as it had been on the night of the burglary. Beside the window, two chairs were tilted against the wall. And on the floor beside them was not only one match, but *thirteen!*

On the evening before the robbery, the mine official and a friend had sat smoking by the window for hours, tossing used matches on the floor. May carefully gathered up the thirteen little sticks in his hand. Luck was with him. Twelve were grooved in the shafts. The thirteenth was round and crimped at the end.

"This is the one I want," he said, and turned to a powerful portable microscope. Under it, he studied the tiny stick. A

minute stain of grease, a speck of coal dust, a glint of metal, a filing composed of iron and brass used in brazing, a particle of some strange fiber unlike any in May's extensive collection, told their story. Ten clues he found on the single match. Calling at the engine rooms of the seven mines in the vicinity, the detective learned a cylinder head had blown out at one on the day before the robbery.

"Where's the man who did the filing on that brazing job?"

A WORKMAN was brought in and from under his finger nails May scraped bits of coal dust and specks of iron-brass filings. He then stripped off the man's work clothes and revealed a second suit, of unusual make and texture. In the pockets he found matches, round ones crimped at the ends. Bits of fiber taken from the lining of the pockets proved identical with the mysterious thread particle discovered on the thirteenth match. Before they reached the sheriff's office, the captured thief confessed his guilt. Out of the 700 men in that Idaho mining town, May had picked the guilty one with a single match as his only clue!

Because bits of dust and metal are so often vital to the solution of a baffling crime, special attention is being given to their study in the scientific crime laboratories of Europe and America. The famous French microscopist, Dr. Severin Icard, has just announced remarkable success in identifying the work a person is engaged in by studying the dust in his watch.

Granules of carbon, for instance, are always found in the watches of garage mechanics and coal workers, particles of metal in those of machinists, and grains of clay in those of masons. In the timepieces of barbers are tiny fragments of hair and in those of violinists specks of rosin.

In Germany, scientific sleuths of Berlin have made similar studies, analyzing the occupational dusts found in clothing. For months, one French detective analyzed the dust particles he discovered in the eyebrows of criminals, and another studied specimens found in the wax of the ears. Part of the laboratory equipment of the expert scientific detective is a collection of dusts for comparison purposes.

FOR justice often hangs on the testimony of these eloquent particles. In one microscope room where I spent hours watching these scientific crystal gazers at work, I saw layers of dust on a criminal's shoe analyzed to trace his movements. Particles of clay, specks of oily dust, shreds of decayed leaves, tiny bits of gravel with a diatom adhering to them, chaff and hayseed, gave a record that enabled the trained expert to reconstruct the path the wearer had taken. He was sure he had walked on an oiled road, crossed a clay field, entered a wood, passed up the bank of a stream, and stopped at a barn. Such information in a score of cases has proved instrumental in breaking down alibis and placing a suspect at the scene of a crime.

Detective Leddy, of the New York Police, using his glass in a study of the articles found in celebrated Snyder-Gray murder

Another dramatic phase of this battle against the criminal, in which gleaming lenses play a leading role, is the study of scratches and knife marks.

Not long ago, a scientific detective in the West traced a threatening letter to the sender by means of microscopic knife marks left on a lead pencil shaving! The bit of wood accidentally found its way into the envelope in which the letter was mailed. Photomicrographs of the infinitesimal grooves and ridges on the shaving corresponded in every detail with similar markings made by a jackknife taken from the pocket of a suspect.

IN RECORDING the markings left by larger knives, hatchets, and axes, the cutting tools are sliced through a block of beeswax, the cross sections of the block recording a perfect picture of the identifying ridges and grooves.

But scratches made by woodworking tools are not the only ones to give the trained sleuth illuminating clues. Those on metal are important, too. One day, when I was discussing this phase of the work with Colonel Calvin Goddard, head of Chicago's Scientific Crime Detection Laboratory, he said: "You can't make the same mark with a file twice." And that is true. Under the all-seeing eye of the microscope, the minute variations in speed, angle, and pressure become evident. Also, each tool, as well as each knife, leaves its identifying mark. Take a recent case in California.

A PAIR of clever lock breakers, preying upon telephone pay stations, had reaped a rich haul in towns along the coast. For six weeks they carried on their raids, opening the coin boxes with special punches and screw drivers and escaping before the thefts were noticed. Finally, police nabbed two young men in a Seattle, Wash., hotel. Hidden under the mattress in their room were punches and other tools. That was the only evidence against them, however—insufficient for a conviction.

A scientific detective was asked to examine the tools. Under his high-powered microscope, scratches on the last-robbed coin box and those produced by the confiscated tools jibed to the tiniest detail. In the space of an eighth of an inch, his lens revealed 100 major identifying marks, some only one ten thousandth of an inch wide! On the strength of this amazing, subvisible evidence, the two suspects stayed in jail.

Another dramatic phase of the work with microscopes was told to me by Dr. Herman N. Bundesen, then Chicago's crime-fighting coroner. A few years ago, police were on the trail of two of the most dangerous men alive, the red-handed gunmen, Scalice and Anselmi. These swaggering desperados of the underworld had killed a dozen men with their own hands.

TELLTALE DUST SPECKS

An analysis of the soil found clinging to the shoe of a suspect made it possible to trace in detail the exact path he had followed in going for some distance across the fields

ARRESTED in a taxi on Michigan Avenue, they grinningly submitted to search. No guns were found on them. But hidden behind the seat of the taxi, officers discovered a pair of loaded automatics. Jailed on a temporary charge of carrying concealed weapons, the gangsters maintained they had never seen the guns before. Their lawyer subpœnaed the records of the taxi company, proved eleven people had ridden in the same cab that day, declared any one of them might have secreted the weapons.

"How do you think we pinned the guns on the gangsters?" Bundesen asked me.

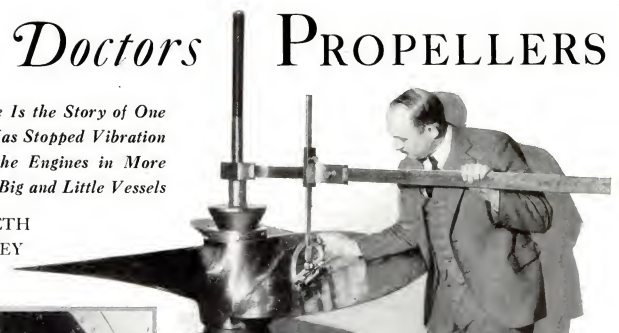
"By fingerprints?" I suggested.

"No. They were too blurred to be of use. But in the barrels of the automatics we discovered bits of fuzz, fragments of fiber from the linings of the pockets where they had been carried. We got the gangster's (Continued on page 142)

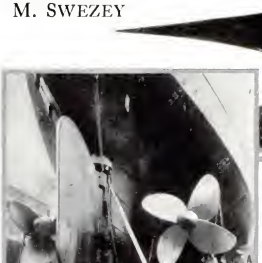
He *Doctors* PROPELLERS

• • Here Is the Story of One Man Who Has Stopped Vibration and Saved the Engines in More Than 20,000 Big and Little Vessels

By KENNETH M. SWEZEY



Bert O. Godfrey with his pitchometer, with which he determines the exact pitch of every part of a propeller blade so accurate adjustment is possible



Here is the driving mechanism of a big liner. Speed and quiet depend upon pitch of propellers

WORKING long hours in a building near the water front of Brooklyn, N. Y., is a specialist who has no counterpart in the rest of the country. Bert O. Godfrey is an expert diagnostician and doctor of the ills of ships' propellers.

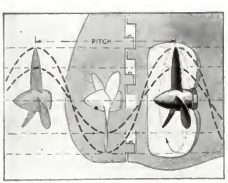
At the rate of nearly forty a day, propellers are brought to him in an ailing condition, and, in almost every case, taken away cured. Propellers with battered and twisted blades, propellers with incorrect or uneven pitch, racing-boat propellers that must be adjusted with micrometer accuracy to a certain prescription, yacht propellers that must be cured of every minute unevenness that might cause inefficiency or vibration—all these types find their way continuously to Godfrey's shop.

To the average layman, to whom all propellers look more or less alike, it is astonishing to learn that by bending a huge bronze blade an inch or two, or even a fraction of an inch, it is possible to increase a ship's speed three or four miles an hour, to eliminate vibration and engine smoking, and occasionally to eradicate a combination of troubles which, if allowed to grow, might eventually seriously damage both engine and ship. Yet, to Godfrey, such results are not only theoretically possible, but are a part of everyday routine experience.

In locating the faults of propellers, his chief aid is an instrument of his own invention, the "pitchometer." This consists of a mechanical device capable of measuring with paper-thickness accuracy the angle of tilt of any portion of a propeller blade, and an elaborate chart showing in an instant the exact pitch corresponding to the particular angle.

Previous to the invention of the pitchometer, pitch was generally measured by means of what is known as the "old Navy system." A single finger of the instrument was touched to the surface of the propeller blade at a series of predetermined points, and the angle of the blade was calculated from the difference in the elevation of the finger at the various points. The job was indirect and laborious; and unless a tremendous number of points were touched, the calculated pitch could be far from the truth.

The "pitch" of a propeller is not as elusive in theory as it is in practice. It is simply the distance, in a line parallel with the shaft, through which a point on the tip of one of the blades would move, in one revolution, assuming, of course, the water in which the propeller turns to be a solid medium. Each propeller blade corresponds to a segment of a screw, which turns in a threaded nut. For each complete revolution of a blade, the propeller advances a distance depending upon the angle that the blade is tilted. The distance of advance equals the pitch.



Drawing showing clearly that the center of propeller blade moves through a shorter circle than the tip and so angle must be greater

WHEN a nautical man speaks of a pitch of thirty inches, he means that the propeller's blades are set at such an angle that, were the water a solid medium, the propeller would advance thirty inches for every revolution. For sixty-inch pitch, the propeller would advance sixty inches, and so on.

Understanding how much a propeller blade acts as a segment of a screw turning in a thread, it is not hard to imagine what happens when the pitch is not uniform. Under such conditions, different parts of the blade try to push at different speeds. And the propeller, instead of smoothly utilizing its power in progressing through the water, expends a good part of the power uselessly churning up the water. Being unbalanced in action, its rotation becomes one of the chief sources of ship vibration.

In the last eight years Godfrey has examined and adjusted more than 20,000 propellers. From this experience he has come to the conclusion that scarcely one in twenty propellers in everyday service is true within the necessary limits of accuracy.

Even brand-new propellers are often considerably out of pitch. Not long ago Godfrey was sent a pair of propellers from a practically new Government ferryboat, which had been *(Continued on page 141)*

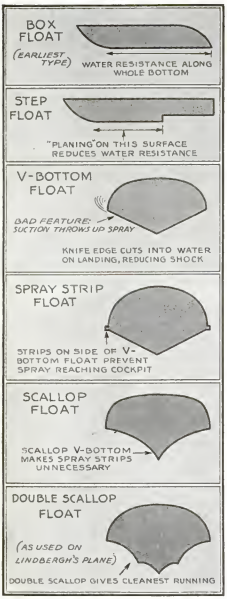
TODAY
Getting a seaplane ready to race for the Schneider cup

YESTERDAY
At right, first seaplane, flown by Glenn Curtiss in 1911

Captain Frank T. Courtney

FAMOUS AVIATION EXPERT TELLS...

WHY *Seaplanes*



The evolution of the seaplane float is shown in this diagram, starting with the boxlike affair used by Curtiss on the first water plane and coming down to the latest design

ONE of the greatest surprises I ever had came when I was going only five miles an hour in a 200-mile-an-hour racing seaplane!

I was testing a 600-horsepower Gloster-Napier near Felixstowe, England, in developing the 1924 Schneider Cup plane. To cool the twelve-cylinder engine, experimental radiators had been fitted to the upper wing, and I took the mosquitolike biplane aloft to test their effectiveness. With the motor wide open, the "winged engine" streaked across the North Sea at 200 miles an hour while I crouched over the instrument board making mental notes on the changes in oil temperature.

After eight minutes, I came down in a fast landing on the relatively smooth water at the mouth of the Stour River. The ship stopped in a cloud of spray, heading into the wind. A motorboat put out from shore to take me off. While I waited, I sat jotting on my pad the figures of pressures and temperatures I had noted in the air. Suddenly, as the motorboat came up, I felt myself leaning far to the left. My safety belt tightened with a jerk. I raised my eyes, and saw the left wing disappearing in the water. The plane was rolling over on its back.

Flipping open the catch on my belt, I scrambled around the belly of the fuselage like a squirrel just as the ship turned over. The heavy engine pulled down the nose, tilting the tail skyward. I shinned up the body like a boy climbing a telephone pole and when the boat came to pick me off, I was clinging to the tail surfaces, trying to figure out what had happened.

Tests later showed a singular thing had occurred. The wind, blowing from the front, had carried the plane back against the rapid current flowing down the river. Water piled up at the rear of the floats, poured over the top of the left float, and depressed it farther and farther until the wing-clipped little plane capsized. As a result of this queer accident, the pontoon design of the racer was altered. Narrow metal strips, tilted up at the rear of the floats, acted as lifting elevators if the pontoons moved backward through the water.

THIS racer was the fastest seaplane I ever flew. Probably the slowest was the lumbering, fifty-five-mile-an-hour Short biplane on which I made my first overwater hop, fifteen years ago. Since then, I have made the first test flights on nearly twenty types of air-and-water planes, from the tiny folding-wing submarine craft shown on page forty-eight of the October issue of POPULAR SCIENCE MONTHLY, to the giant "Valkyrie" flying boat, powered by three 650-horsepower engines and tipping the scales at 30,000 pounds.

Another fact about pontoon-equipped racers, which early tests revealed, recently helped Lieut. G. H. Stainforth ride his blue and silver Supermarine monoplane to a new world's speed record of 415 miles an hour, nearly seven miles a minute.

Few people knew that his bulletlike plane is equipped with pontoons set at unequal distances from the center of the ship. When the big Rolls-Royce engine kicks over the propeller at the start of a take-off run, the float away from which the blades are turning is driven down into the water by the torque, or twisting force, of the motor. To offset this, it was found necessary to set that pontoon farther out, adding to its leverage.

Several readers of this magazine have asked why seaplanes have broken all the speed records of land panes. It is not because air-and-water machines are naturally

FLOATING PLANE TURNED TURTLE

Courtney, seated in cockpit of this plane, had an unusual experience when the craft, while floating quietly, suddenly dipped the left wing and turned on its back

Fly with Bullet Speed

faster. Probably a land craft could be built to beat the speediest seaplane. The difficulty would be in finding a field big enough for the take-off and landing. The latest Supermarine has a stalling speed of about 105 miles an hour. A ship coming down on wheels at such a rate would roll beyond the boundaries of any present-day airport. For a seaplane, the whole surface of a big body of water is one level landing field.

For this reason, learning to fly over water is ideal for beginners. There are no trees, buildings, or other obstructions to cause a crash, and on calm days a student can take off and land anywhere. The only danger lies in floating logs and timbers. I usually run back and forth over the place where I intend to take off, while I am warming up the engine, to be sure the water is clear of such obstructions. From the air, they can be easily spotted and avoided in landing.

IF YOU are planning to take up water flying, the best thing you can do in preparation is to learn to sail a boat. Hours spent tacking back and forth on a lake, river, or bay will help make an expert pilot of you. It will give you knowledge of the effect of winds and currents that will save time when you start your flying course.

By using the wings for sails, the pilot of a disabled flying boat can sometimes steer for a distant point of land. When one wing is dragged and the other lifted, the craft veers from the direct line in which the wind is blowing it, taking a tack toward the side of the lower wing. The most famous case of this kind occurred in 1919 when the *NC-3*, in a transatlantic attempt, landed with a broken engine nearly a hundred miles from the Azores

Though Courtney has tested many planes, here is the biggest seaplane he has been up in. It weighs fifteen tons

Islands. Commander Towers, in charge of the flying boat, began sailing for the islands, steering a diagonal course by means of tilted wings. Three days later, they floated safely into the harbor of Ponta Delgada.

When a seaplane or flying boat—the former having pontoons, the latter a boat-like hull—is in the air, it operates exactly like a land plane. But on the water, it handles differently. For instance, in taking off in a land machine, the pilot pushes ahead the stick at the start to lift the tail. On a water machine, he does exactly the reverse, pulling it back to raise the forward part of the pontoons or hull out of water to lift it up on its hydroplane step as quickly as possible. The step is an upward indentation, or notch, in the bottom of the float that prevents the water from sticking to the bottom of the hull, thus reducing resistance and increasing speed.

ON A big flying boat, it is sometimes hard to hold back the controls far enough to keep the tail down. During tests on one six-ton winged ship, I had a mechanic put sixteen five-gallon cans of gasoline at the rear of the hull. They made the plane tailheavy and helped in getting off. As soon as I was in the air, I would shove ahead on the control wheel, holding the tail up by main strength while the mechanic ran back and forth carrying the cans forward to balance up the ship.

IN THE early days, pilots of underpowered planes often had difficulty in getting up on the step for a take-off run. Practically all the earlier flying boats I piloted had to be "rocked up on the step" every time the water was calm. By alternately shoving ahead and pulling back on the controls, as we plowed along the water, I would get the ship rocking back and forth until it lifted itself up and hydroplaned on the surface. At other times, we would have a motorboat charge back and forth across our path, creating swells and ripples that helped us start hydroplaning.

The most thrilling attempt I ever made to lift a flying boat on its step took place off the Azores Islands in 1928. I was making final tests on the 1,000-horsepower Dornier machine in which I tried to cross the Atlantic from East to West. The day was perfectly calm, the sea glassy. For more than an hour I plowed back and forth, unable to get the heavy ship out of the water. *(Continued on page 137)*

Genius or Idiot...

How *Tiny Hidden Glands in*

• *Invisible messengers of rage, hate, love; of size, strength, and sex enter the bloodstream all the time from strange organs that may hold the key to the secret of youth and old age or even of death*

Giant, dwarf, and fat woman as you may have seen them in the circus. Each is the product of abnormal action on the part of one or more of the endocrine glands, and each may have had perfectly normal parents

THE origin of the earth and of life on this planet, the development of man, and the manner in which animals change so that new and distinct species arise, have been explained to Michel Mok, staff writer, by Dr. William K. Gregory, of the American Museum of Natural History. Last month, Dr. Herbert Ruckes, of the Biological Faculty of the College of the City of New York, and secretary of the New York Academy of Sciences, disclosed the secrets of the sex mechanism that enable man to hand his characteristics on to his children. But not all of our characteristics, physical and emotional, are inherited. Many of them are the products of the mysterious chemical regulators known as the glands of internal secretion. Dr. Ruckes, in this talk, explains the strange workings of these glands, which are responsible for much of our appearance and behavior.

MR. MOK: Dr. Ruckes, what makes the internal secretion glands important and interesting? What are they for? What do they do?

DR. RUCKES: Next to the nervous system, they are the biggest factor in keeping your body machine in smooth running order. They have a profound effect on your physical health, your mental balance, and your bodily development; and, as a result, on your welfare and happiness. In fact, they play a powerful part in the shaping of your entire personality. Their action, interaction, or lack of action are responsible for such vital matters as growth, size, youth, old age, and decay. It is mainly they that cause a person to be short or tall, thin or stout, high- or low-voiced, bearded or hairless. They probably are at the bottom of certain features of our dispositions—our emotional peculiarities.

MR. MOK: They do have a lot to answer for!

DR. RUCKES: Indeed, they do. Perhaps most important of all, they control the sex of the individual.

MR. MOK: But you told me last month that sex was determined by the parental chromosomes (P. S. M., Nov. '31, p. 38).

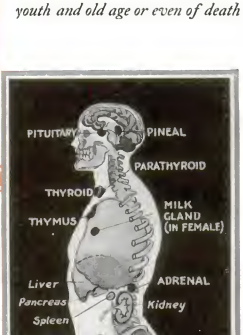


Diagram above shows the position of each of the internal secretion glands which govern life

DR. RUCKES: Quite true. Whether a new individual is to be male or female depends on the chromosomes in the reproductive cells of the parents. But the glands of internal secretion; that is, one set of them, the sex glands, regulate the actual operations of the sex mechanism. They produce the egg cells and the sperm cells, the union of which is responsible for the new individual. Let me tell you a little story. In the Swiss town of Bâle, a remarkable trial was held in the year 1474. The "defendant" was a rooster that had laid an egg.

MR. MOK: An embarrassing situation for a rooster to be in!

DR. RUCKES: Worse than that; it proved fatal. The bird was tried with all due formality, found guilty of witchcraft,

Giant *or* *Dwarf?*

Your Own Body Make You What You Are

TESTING GLAND ACTION

The person inside the mask breathes a specially prepared air and the carbon dioxide given off is measured as a test of basal metabolism which indicates how the glands function

The boy holding this grown woman in his arms is six years old. His strength is due to abnormal glands

This woman, looking as the picture on the left shows, was 49 years old when she began to receive gland extract and X-ray treatment. The picture on the right was taken after she had been receiving treatment for slightly more than one year

sentenced, and burned in the public square. Now, until the beginning of this century, nobody could have told you exactly what caused that rooster to behave in such a ladylike manner. Up to that time, the workings of the glands of internal secretion, also known as the ductless or the endocrine glands, were practically a closed book. The study of this subject still is a young branch of biological science, but several of the mysteries of the endocrine system have been solved, including the cause of occasional egg-laying in male birds. Nowadays, scientists even can make them lay eggs by artificial means. Dr. Michael F. Guyer, professor of zoölogy in the University of Wisconsin, has made this experiment with a common rooster, and Dr. Oscar Riddle, of the Carnegie Institution, an eminent authority on internal secretion and reproduction, did it not long ago with a male pigeon.

MR. MOK: What exactly is wrong with a rooster that lays an egg? And how can the bird be made to do it artificially?

DR. RUCKES: I will explain that presently. First, I want to tell you of another function of the ductless glands. These glands determine the secondary sex characteristics.

MR. MOK: What are they?

DR. RUCKES: Such things as bodily form and proportions; for example, the broad shoulders and narrow waist of a man and the narrow shoulders and broad hips of a woman; the low male voice and the high female voice.

MR. MOK: Do the two sexes differ also in their mental characteristics?

DR. RUCKES: Very little, if at all. However, the emotional lives of the two sexes may be and often are different. In other words, men and women think in pretty much the same way, but their feelings vary frequently.

MR. MOK: Speaking of proportions, you told me last month that the glands of internal secretion sometimes cause normal parents to have midget or giant children. How does that happen?

DR. RUCKES: A dwarf is an individual who did not grow enough and a giant is one who grew too much as a result of the influence of certain hormones on their systems.

MR. MOK: What are hormones?

DR. RUCKES: Hormones, or endocrines, are the chemical fluids produced by the glands of internal secretion. These glands have no outlets, and therefore are also known as the ductless glands. The chemicals they produce are absorbed directly by the bloodstream through the extremely thin walls of the smallest blood vessels. In that way, the hormones are carried to all parts of the body and create general effects, no matter in what part of the anatomy the glands that discharge them may be located.

MR. MOK: What are some of the ductless glands?

DR. RUCKES: The principal ones are the thyroid, located in the throat; the pituitary, found at the base of the brain; the adrenals, attached to the surface of the kidneys; the pancreas, embedded in the coils of the small intestine, and the glands of the reproductive system, called gonads.

MR. MOK: Will you please explain their functions?

DR. RUCKES: The thyroid is chiefly concerned with growth, and it is this gland which, in certain abnormal cases, is responsible for one kind of dwarf, as you will see in a minute. Besides, the thyroid governs the general body changes.

MR. MOK: What do you mean by body changes?

DR. RUCKES: I can explain that best by

Drawn from photos in possession of Chemical Foundation

On the left, condition of child suffering from cretinism; and right, the same child after thyroxine had stimulated defective thyroid

an example: If you remove the thyroid gland from a tadpole, it will go on growing, but it will never change into a frog. On the other hand, if you take another tadpole, permit it to keep its thyroid and, in addition, feed it thyroid extract or inject the extract into the creature, that tadpole will change within a few days into a full-fledged frog which, however, will remain quite small for a while. These are famous experiments that are often made in the laboratory to demonstrate the effects of the thyroid hormone.

MR. MOK: But human beings do not undergo any such body changes, do they?

DR. RUCKES: Indeed they do, but the changes are not so pronounced. In the course of our lives we not only grow but we also change our shapes and proportions. A boy, for instance, is not a miniature man; the adult has an entirely different figure. This change is regulated largely by the thyroid.

MR. MOK: What abnormalities does it produce?

DR. RUCKES: Excessive growth of the thyroid is responsible for the common disease known as goiter. It occurs from two to three times as often in women as it does in men. Thyroid deficiency produces a condition called cretinism, which is a form of dwarfishness. Often such dwarfs are sterile; that is, they are unable to have offspring, and then they usually retain their childlike characteristics. In advanced cases of cretinism, an imbecile mind is believed to be a symptom of the disease. The performing midgets you have seen on the stage are cases of cretinism. As a rule, they are perfectly formed small human beings but with childish faces and treble voices. Occasionally, these dwarfs are not sterile. You then get mature men and women in miniature who marry and have children. In some of these cases, cretinism is inheritable and may produce a dwarf race.

MR. MOK: In other words, pygmies are people who pass their thyroid deficiency on to their offspring, and the midgets on the stage simply are people who haven't enough thyroid but are unable to hand down that characteristic?

More Amazing Facts in the Thrilling Story of Life — The World's Greatest Mystery

DR. RUCKES: Precisely. Our attitude toward our abnormal fellowmen has not changed much since the days when kings used monstrosities as court jesters. Freaks still seem to amuse us. The best known case of cretinism of modern times was "General Tom Thumb," who for years was exploited by P. T. Barnum. Perhaps the most famous dwarf in history was Jeffrey Hudson, who was born in 1619 in England of normal-sized parents. When he was eight years old and a foot and a half high, his father presented him as a gift to the Duchess of Buckinghamshire. One day, when the Duchess was entertaining King Charles I at her castle, she had the midget served in a pie. The King was so delighted with him that he confiscated him and kept him at court for many years. In a spirit of fun, Charles knighted him. Jeffrey remained eighteen inches high from the time he was eight until the age of thirty, but when he died in his sixty-third year, he was three feet nine inches tall. The dwarf had a checkered and romantic career. He was kidnapped by Dutch privateers, and sold into slavery by Barbary pirates, but finally escaped and returned to England to become captain of cavalry in the royal army! At one time he killed a full-sized man, who had made fun of his stature, in a duel, and later was imprisoned on charges of hatching an anti-clerical plot.

MR. MOK: Quite a life for a little fellow! Can a dwarf be changed into a person of normal stature?

DR. RUCKES: Yes, in two ways; either by injecting small amounts of thyroid extract, or thyroxine, or by the feeding of iodine salts, which form the chemical basis of thyroxine. This has been tried successfully with dwarfs in the adolescent stage. A remarkable case of successful treatment by thyroxine occurred only the other day. The patient was a boy in the State's Research and Educational Hospital in Chicago. Like most cretins in the advanced stages of the disease, the child had never uttered a word, and his condition was considered hopeless until one of the physicians began treating him with thyroxine injections. At first, there was no improvement. But as the quantity of thyroxine was increased, the child began to speak. In this way, he revealed that he had been absorbing knowledge all the time, though he was considered an imbecile. He simply had been unable to talk. While this is a single case, it may lead to the discovery that victims of cretinism in its aggravated form, who have been regarded as imbeciles until now, merely are mutes. According to the latest reports, the boy's physical condition also is improving steadily and he is on the way toward becoming a normal child.

On the left note general emaciation due to old age, and on the right the greatly improved condition following a gland transplantation operation, the lasting effects of which, however, are uncertain

MR. MOK: You said that injections of small amounts of thyroxine are sufficient to change a dwarf into a normal person. Is thyroxine so powerful?

DR. RUCKES: It is. All the hormones are extremely powerful, and the glands produce their chemicals in very small amounts. A minute quantity of thyroxine will work a formidable change. *One one-thousandth part of one gram speeds up the body changes at the rate of three percent.* Since iodine salts are the basis of thyroxine, it is interesting to know that goiter is common in places where the iodine content of soil and water is low; for instance, in the Great Lakes region. The disease can be prevented by eating food that contains iodine or by adding iodine salts to the diet.

MR. MOK: But I thought you told me that goiter was a result of excessive growth of the thyroid gland? If that is so, I should imagine that these people would have too much iodine instead of not enough.

DR. RUCKES: It is quite natural for you to think that, but it is not the case. As Professor Guyer explains it, the gland enlarges through overwork in its efforts to supply the body with enough thyroxine despite the insufficient intake of iodine. Besides, the size of an endocrine gland has nothing to do with its potency; a large gland does not necessarily produce a stronger hormone or more of it. The reason is that the enlargement is due directly to an increase in the number of cells that make up the connecting tissue, and not of those constituting the part that secretes the hormone.

MR. MOK: You said that cretinism produces only one kind of dwarf. What is the other?

DR. RUCKES: The second type of dwarf is due to a lack of the chemical produced by the front part of the pituitary. This gland, about the size of a hazel nut and located on a stalk on the floor of the skull at the base of the brain, consists of two small lobes, each with a different function. The fluid produced by the back lobe seems to influence the blood pressure and other bodily operations. The chemical secreted by the front lobe helps to regulate the growth of the body, but has very little influence on *(Continued on page 131)*

Why does nobody KNOW *this* MAN?

HIS picture should be in every school history. His name should be as familiar as that of Columbus or Robert Fulton, for he performed one of history's epochal feats!

Before the Wright brothers were born, long before the days of internal combustion engines, this American invented, built, and flew a *successful airship*. Unknown today, he is, however, a real Father of Aviation.

He could make his ship go where he wanted it to go—as he demonstrated in 1866 by a point-to-point flight with three passengers.

So good was his ship that for the first time in history people put cold cash into the future of air transportation by investing in his chartered "Aerial Navigation Company" for the carrying of freight and passengers.

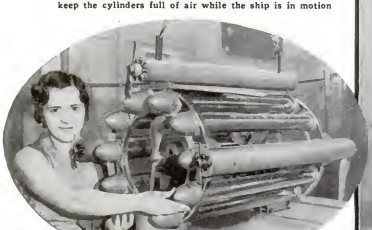
Why has his achievement escaped the historians? Has the record been deliberately suppressed? On twenty-seven different dates the United States issued patents to him for important inventions, for he was a famous inventor and a citizen of consequence before the Civil War. He was probably the first to fly a navigable aircraft, and documentary evidence discovered and assembled by POPULAR SCIENCE MONTHLY and never before published will now secure for him his place as a great pioneer of flight.

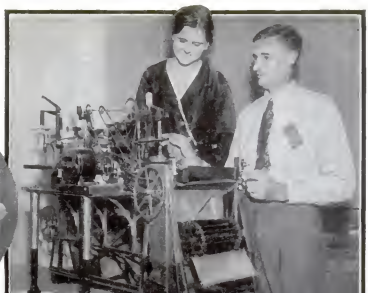
In the January issue of POPULAR SCIENCE MONTHLY his astounding and dramatic story will be told for the first time. With the article will be published the curious and interesting pictures of his airship, a souvenir of the first flight, signed by his passengers, and the reproduction of newspaper reports of the day which state, with all the excitement that such an event should arouse, "The Problem of the Centuries has been Solved!"

The publication of these forgotten facts of history will create a sensation in all quarters.

• *Be sure that you are among the first to read these exciting revelations in the January* POPULAR SCIENCE MONTHLY, on sale December 1st at all news stands.

WILL IT FLY? Below is one of the strangest inventions shown at the Chicago International Exposition. It is a model of a new type of aircraft. The cylinders are for compressed air, which helps to run the five sets of propellers working as stabilizers at the stern of the machine. Motors keep the cylinders full of air while the ship is in motion





DOESN'T NEED A DAM. This compact water motor, exhibited at Chicago, is designed to run and furnish power without the necessity of building a dam. Its inventor says it will work well in a swift stream

30,000 Models at

DOES the world need a new folding chair or an improved water wheel to solve its ills? Whatever its wants, they were likely to be seen in some form at the second International Patent Exposition, held recently at Chicago. Twenty-five thousand men and women inventors brought models of their pet creations, 30,000 in all, to make the monster show unprecedented in this country, and perhaps in the world. What our photographer saw as he strolled among the exhibits is shown on these pages. Following the success of this and the first exposition (P. S. M., July '31, p. 68) in providing a meeting place for inventors and buyers of patents, the next patent show is already being planned for New York.

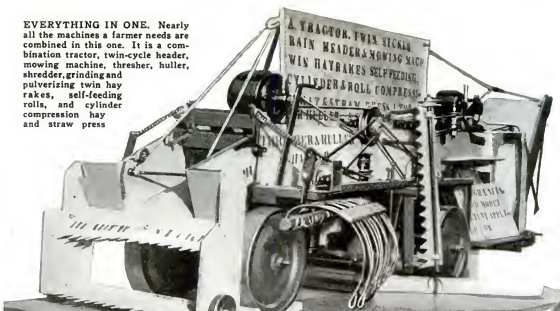
MERELY TWO CHAIRS IN ONE. At upper left is what looks like an ordinary armchair, but it is a good deal more than that. Within it, there is a folding bed that is extended in photo immediately above

PROWLER FIRES SHOT. When the device shown on window frame above is used, opening window discharges a cartridge, blank or loaded, as an alarm

IT CAN'T SKID. Inside the soft sponge rubber mitten shown at right, a cake of soap is placed and it can thus be held firmly without skidding out of one's hand onto the floor

NOT WHAT IT SEEMS. You may think the machine at right is a vacuum cleaner but it really is a burner used to soften tar bumps on concrete roads

Inventors' Show



EVERYTHING IN ONE. Nearly all the machines a farmer needs are combined in this one. It is a combination tractor, twin-cycle header, mowing machine, thresher, huller, shredder, grinding and pulverizing twin hay rakes, self-feeding rolls, and cylinder compression hay and straw press

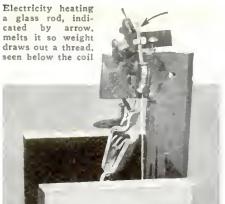
ONE-RUNNER COASTER. Below is a bicyclelike frame mounted on a single runner with handlebars and foot brake, designed for rapid travel down an incline on the snow or ice

HOSPITAL IN CHAIR. Just about all a sick person could want is tucked away in this chair, as it has room for clothing, towels, hot water bag, food tray, and tray table

WALK ON THE WATER. To use the invention shown above, one steps into the boat, puts his feet in the boots, and wades into the water. When the water is too deep for wading he simply keeps on walking, and the boat floats him so that steady progress is easy

OUR HELP APPLAUDED. In recognition of the aid *Popular Science Monthly* gives struggling inventors, photographic enlargements of the page on which this magazine heralded the first patent show a few months ago appear on the walls of the Chicago exposition. One is seen behind this combination ironing board and stepladder designed by a woman

Electricity heating a glass rod, indicated by arrow, melts it so weight draws out a thread, seen below the coil



SPIN GLASS SIGHT FOR SURVEYING TELESCOPE

A METHOD resembling that used in pulling taffy is employed by Government scientists in Washington, D. C., to make surveying telescope sight wires of glass. A tiny rod of glass is clamped at the top of the contrivance used in this operation. One end of the rod, to which a small weight is attached, comes just within the loops of an electric coil of high-resistance metal. When current is turned on, the coil becomes intensely hot, reducing the end of the glass rod to a partly fluid state. Then the weight attached to it drags it out to a thread almost too tiny to see. Spider webs and human hair once were used for these sight wires, but they became slack in wet weather. Platinum wires, then tried, were too brittle, and many broke while being installed. No trouble has been experienced with the glass thread, which is as delicate as a strand from a spider's web, in a series of experiments.

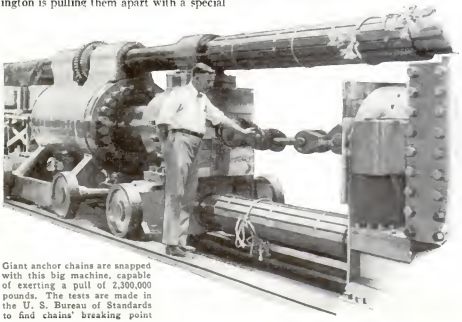
SUN STOPPED FOR CAREFUL STUDY

Below, a four-inch image of the sun reflected on a piece of cardboard, and right, mirrors used to hold image motionless, exactly as though sun stood still

AN INSTRUMENT that will stop the sun in its tracks, so scientists can study it, has just been installed at the University of California. This apparatus, known as a coelostat, consists of three surface-plated mirrors that reflect the sun's image into a spectrograph forty feet away in an observatory building. The sun is stopped by moving the primary mirror to compensate for the earth's motion so that the solar image remains stationary. The reflector keeps step with the sun by means of a tiny specially built electric motor operating through a series of gears. A four-inch image of the sun is reflected down a thirty-foot wooden tube to the spectrograph. An uninterrupted reflection of the sun is had by placing a piece of cardboard over the outer end of the spectrograph when sun spots become plainly visible to the naked eye. The coelostat allows a study of the sun with bulky instruments not attached easily to a moving telescope.

HUGE MACHINE BREAKS ANCHOR CHAIN

How strong are the links in a ship's anchor chain? In spite of the fact that they are made of heavy alloy steel, specially designed to withstand big loads, there must be some point of strain at which they will yield. In order to find this breaking point for each type of chain, the U. S. Bureau of Standards at Washington is pulling them apart with a special testing machine capable of exerting a pulling power of 2,300,000 pounds. So far it has not been necessary to call upon the machine's limit of power to snap the links. Before this is reached, the chain parts, and a record is made of the exact amount of force necessary to break it. This is a guide to correct chain to use for each ship.



Giant anchor chains are snapped with this big machine, capable of exerting a pull of 2,300,000 pounds. The tests are made in the U. S. Bureau of Standards to find chains' breaking point

BIG STEEL MOUTH TAKES BITE OF SEA'S FLOOR

A POWERFUL "mechanical mouth" has just been perfected to aid the U. S. Coast and Geodetic Survey in its work on Georges Banks, off the New England coast. This device will dive to the bottom, gulp up a sample of the sea's bed, and bring it to the surface for inspection and record. The contrivance is lowered to the ocean floor with its jaws wide open. Striking the bottom trips a catch and the jaws close with a vicious snap, imprisoning a specimen of the bottom. The device is then hauled to the surface.

Rain Making Machine Clears Snow from Street with Hot Water

SNOWDRIFTS that paralyze traffic and block sidewalk crossings vanish before the onslaught of a new machine that melts them with artificial rain. Just patented by Curtis D. Chase, of Philadelphia, Pa., this revolutionary device may soon appear on city streets. It is designed to displace the machines that attempt to remove snow with searing flame. In the new snow melter volumes of hot water at only 100 to 180 degrees Fahrenheit penetrate the mass of snow and melt it. In response to a hurry call, one of these machines will follow the snowplows through a street and attack the piles of snow that they leave. An endless chain feeds the snow to the oil-fired melter, which trails behind a tractor. Here a series of nozzles spray it with the hot water "rain." The melted snow, now turned to lukewarm water, is used to flush the street clear; or if there is danger of refreezing, it is carried through a hose to a storm sewer. Tests show that the machine, whose operation is made clear in the accompanying diagram, can remove a six-inch snowfall from a street forty feet wide at the rate of a mile in four hours. Any standard loader can be used to feed the snow to the melting apparatus.

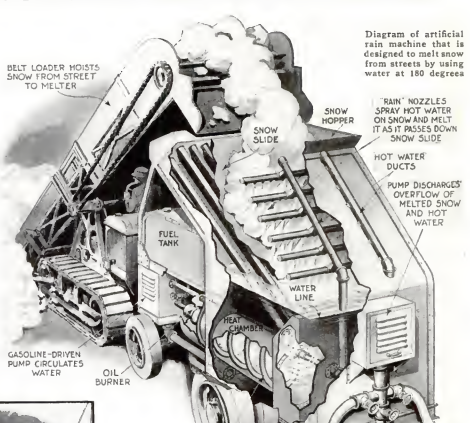
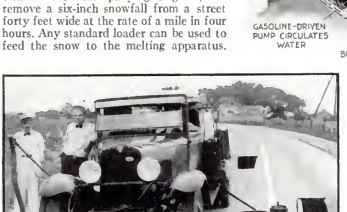


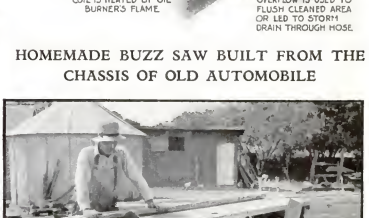
Diagram of artificial rain machine that is designed to melt snow from streets by using water at 180 degrees



AUTO PAINTS TRAFFIC GUIDE ON ROAD

TO SIMPLIFY the task of marking a white traffic line squarely in the middle of a highway, a special type of automobile has recently been patented by a North Carolina official. Guided by a disk on the right front wheel, which hugs the shoulder of the pavement, the car in a few hours lays a stripe that a crew of several men would require a week to finish. The line is applied by a paint spray gun mounted between two revolving disks. When the paint in the tank runs low, a whistle blows.

HOMEMADE BUZZ SAW BUILT FROM THE CHASSIS OF OLD AUTOMOBILE



Above, homemade buzz saw built from the chassis of an old automobile

To SAVE labor and time on the job, a Greenfield, Ind., carpenter and contractor built a homemade circular saw from an old flivver chassis. First he cut down the radiator so that it would not project above the sawing platform, which was then built of four two-by-six boards. The saw itself, a buzz saw mandrel cut to fit, was attached to the frame with angle irons and was arranged to be driven from the car's drive shaft. The motion of the saw is controlled by a foot pedal. Gables and rafters can be cut out in a few seconds with the saw.

TREE GROWS, BUT NOT UP

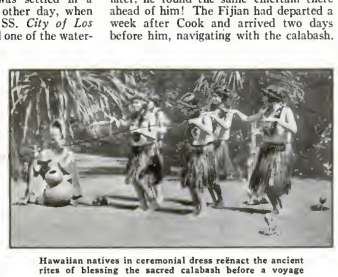
MOST people imagine a tree as growing upward, right from the ground—yet the unusual photograph reproduced here furnishes striking evidence to the contrary. When this twenty-inch-thick elm was only a sapling, two barbed wire fence strands were nailed to it. Though many years have passed and one of the strands is now completely embedded in the trunk of the tree, they have not been carried aloft but have remained practically at the same distance from the ground, indicating that the tree did not grow from the ground up.

At left, wire fastened to tree is raised only a short distance from ground as tree grows big

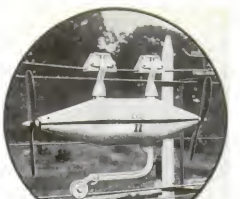
Age-Old Calabash Navigates Modern Liner

First Officer W. L. Johnson of *City of Los Angeles* used this calabash to navigate ship

WOULD "sacred calabashes," used by South Sea Islanders centuries ago to navigate their canoes, serve to guide a modern liner? That question was settled in a unique experiment, the other day, when the first officer of the SS. *City of Los Angeles* successfully used one of the water-filled gourds as a sextant on a voyage from Hawaii to California. In conjunction with the proper declination tables, the calabash checked with the best of up-to-date instruments. This novel test helps to explain the amazing feats of the bronze-skinned natives of the South Seas, who set forth without fear on 2,000-mile voyages long before Columbus braved the Atlantic. Such was their fame as seamen that the Samoan archipelago bears to this day the alternate name of "Navigators' Islands." The sacred calabashes that they used, according to the Bishop Museum in Honolulu, which possesses one of the little-known instruments, were probably invented thousands of years ago. They were called "sacred" because native priests kept secret the methods they used to work out tables, years ahead, for the positions of the sun and the Pole Star. A priest and his calabash accompanied every seafaring expedition. In use, the calabash was filled with water up to a row of four holes equally spaced around the rim. This served as a leveling device, for if the instrument were not held horizontal water would spill from the holes. Then the observer sighted at the pole star through the hole nearest his eye and over the opposite edge. With the aid of the star tables, he could then reckon his position. Had Europe possessed this instrument instead of the crude "cross staff" of Columbus' time, America might have been discovered centuries earlier. Even after the first sextant was invented, a British explorer, Capt. James Cook, saw the pride of Europe's inventive genius outdone. He left Fiji, bidding a native chieftain farewell on the beach. Arriving at Hawaii, some months later, he found the same chieftain there ahead of him! The Fijian had departed a week after Cook and arrived two days before him, navigating with the calabash.



Hawaiian natives in ceremonial dress reënact the ancient rites of blessing the sacred calabash before a voyage



TORPEDO CARRIES MAIL 200 MILES AN HOUR

TORPEDO mail carriers that would whiz across country at 200 miles an hour, on specially constructed cable runways, are under consideration by German postal authorities. Letters now transported by air mail would be rushed even more quickly, and at an increase of only a few cents over ordinary postage, between the farthermost frontiers of the country under the proposed system. Perfected by a Berlin engineer, Richard Pfautz, it already has been demonstrated experimentally. The mail carrier is a streamlined projectile, driven by air propellers at front and rear. Motors within the body of the carrier take their power from the electrified cables on which it runs. The German postal ministry is studying the project.

COUNTING METAL MONEY MADE THIS MAN SICK

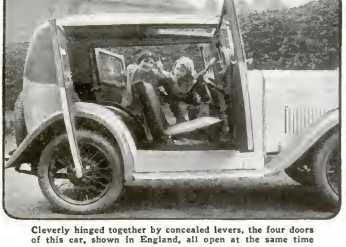
HUNGARY has one man who cannot handle coins. His odd case was recently reported to the Hungarian Dermatologic Society when he developed a form of eczema about his hands, shoulders, and neck that defied explanation. Doctors, asking his profession, found he was employed by a Budapest street car company to count silver, nickel, and copper coins. Tests with metal solutions proved that handling money was responsible for his ailment. He requested and obtained a change of work, and his trouble was cured in a month. Doctors diagnosed it as "hypersensitiveness to metals," caused by minute quantities of metal dissolving on the skin and being absorbed.

CLEANS OIL TEST ROD

A HANDY wiper for the rod that a motorist uses to test the amount of oil in the crank case bolts to the engine near the oil filler hole. By drawing the rod through the wiper pads, it is instantly cleaned so that it will give a clear indication of the depth of the oil when immersed in the reservoir.

This pad near the oil filler hole cleans rod for accurate test

CAR'S FOUR DOORS ALL OPEN TOGETHER



Cleverly hinged together by concealed levers, the four doors of this car, shown in England, all open at the same time

THERE's no difficulty in getting into this new car—or out of it—for the four doors open all at once. Cunningly hinged together by concealed levers, they proved a startling innovation at a recent British motor show. Both convenience and safety are served, for a child cannot open the rear door while the car is in motion without the driver's knowledge. Another feature is a removable roof panel.

GIANT IN WOOD GUIDES FLYERS

A SIXTY-FOOT giant, carved from wood and set up at the Municipal Airport, served to mark a turn in a Los Angeles air race a few weeks ago. Guy wires supported the unusual pylon to keep the wind from blowing it over. In the photograph, a plane is seen rounding the turn of the 100-mile course. The size of the pylon is emphasized by the people and the automobile that can be seen standing beside it.

This figure guides flyers

KEYBOARD CONTROLS BIG MILL

Its keyboard suggests that of a piano, but no music comes from the instrument shown in the photograph who find a rhapsody in motors and the clanking of metal. Its theme song is the roar of modern industry. By manipulating the electric keys, the girl in the picture can control all the machinery of a giant steel mill. Her fingers govern auxiliary mill drives, while the foot pedals will in two seconds reverse a pair of 5,000-horsepower motors running at full speed. A single operator at this new keyboard, developed by General Electric engineers, does the work of two or more men throwing switches.

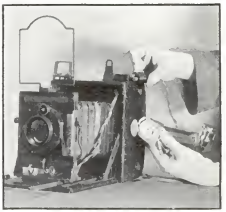
save to those the whine of

INCOMING RATS GASSED IN SHIPS

INSPECTORS of the U. S. Public Health Service keep undesirable alien rats from our shores by gassing them in all incoming ships. In one method of killing possible plague-bearing rodents, a contrivance resembling a welder's torch is used. An air line and gas line terminate at its nozzle. This is thrust into a ship's ventilator, all other openings having been sealed up, and gas and air are turned on. Pressure of the air forces poison gas down into the vessel so it permeates all her interior compartments. When this means of fumigation is employed it is not necessary that the ship be unloaded. Another method, for the practice of which it is necessary that the ship's cargo be discharged, is the scattering of wafers, slightly larger than a fifty-cent piece, by men in masks. Poison gas escapes from them as soon as the tin container is unsealed. With both these methods of gassing rats it is necessary that the crew leave a ship, for the gas used is deadly to humans as well as rats. The ship is entirely sealed and warning signs and sentries are posted at her gangways during fumigation. After the gas has been given time to do its work, the ship is opened and inspectors go about collecting the dead rats. They are taken to a U. S. Public Health Service laboratory to be carefully examined as possible carriers of deadly plague germs.

Above, blowing poison gas into a sealed ship to kill rats; in circle, warnings to keep men away; and, at right, gathering dead rodents

CAMERA SHUTTER FIRES FLASHLIGHT BULB

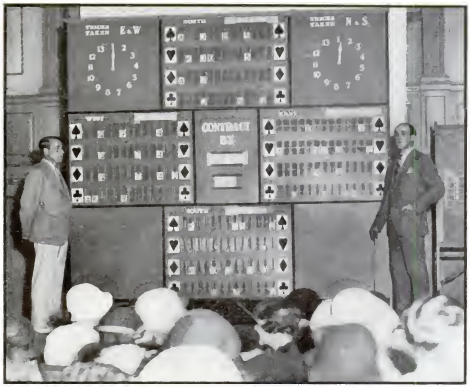


NIGHT snapshots are simplified by an attachment that simultaneously operates a flashlight bulb and camera shutter. A holder carrying flashlamp and batteries screws into the camera's tripod socket. An electric connection is made to the shutter. When the photographer presses the shutter release, its tripper arm fires the bulb while the shutter is open.

NEW BRIDGE PENCIL

A NEW pencil, designed especially for the bridge table, also serves as an indicator of the trump. It resembles the familiar fountain pen desk set. The sheath may be swung over any one of the four suits indicated on its base, or pointed upright for "no trumps." A square tip keeps the pencil from rolling off the table. The set folds flat to be put away.

New Scoreboard Lets Hundreds See Champions Play Contract Bridge



This scoreboard was used in New York City recently so hundreds of spectators could watch the play of bridge experts. The board, showing play in detail, was hidden from the players

More than 600 bridge teachers and their guests crowded the ballroom of a New York City hotel, the other night, to watch the first exhibition match of its kind of contract bridge. Every spectator was able to follow the game play by play, thanks to a newly devised scoreboard visible to the audience but not to the players, and resembling those used in football games. As four bridge experts began their game at a table on a stage, two men behind the cleverly designed steel scoreboard clicked symbols into place that showed what cards each of the contestants held. The winner of the declaration, and his bid, next flashed up at the board's center. Then as an announcer called the name of each card played, an assistant at the board moved the symbol of the card. Dials at the side of the board registered the number of tricks taken by each side. Applause greeted especially brilliant plays. Enthusiastic spectators hailed the invention as marking the début of bridge as a public sport and predicted that future national bridge championships might be fought out publicly in great arenas, with the new scoreboards registering the plays and permitting thousands of enthusiasts to watch leading players in action. Also, seeing which cards the experts play would prove instructive to beginners.

ARIZONA FOREST EATEN BY THOUSANDS OF DEER

Most hunters probably will not believe that at least one area in this country has too many deer. When the Kaibab plateau of northern Arizona became a Government game preserve in 1906, the killing of deer was prohibited. But predatory animals were hunted down. With their enemies gone, deer multiplied until 40,000 roamed the preserve in 1924, when the restriction against shooting them was removed. But despite hunters and a dwindling food supply, 20,000 head still constitute a problem so serious that a committee of more than twenty scientists and members of the National Forest Service has just completed a survey. It estimates that from ten to fifty years will be required to repair damage done to the forests by hungry deer. Its startling recommendation is that the hunting of predatory animals that once held the deer in check be stopped.

This photograph shows only a few of the twenty thousand deer that are destroying the forest preserve on the Kaibab plateau, Arizona. Hunters have failed to stop their rapid increase

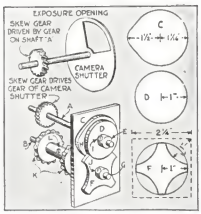
TEXAS HOME BUILT OF PETRIFIED WOOD

Ross R. Wolfe, center, of Stephenville, Texas, shows his petrified plants to scientists. Dr. G. R. Wieland, of Yale, is at extreme right

At left, the house and part of the inclosing fence built of petrified wood and other fossils collected in seventeen states and many foreign lands

A house of petrified wood is the unusual dwelling that Ross R. Wolfe, Texas pecan nurseryman, has built for himself. A collector of fossils in his spare time, he gathered the materials from seventeen states and some foreign countries. His most prized specimens of fossils are grouped in an exhibit within the house, where they have attracted not only laymen. but scientists from leading universities. Outside, a remarkable fence borders the drive. One of its columns is made of flat stones, with knobs, which Indians used to grind their corn into flour for bread. They can be seen in the photograph. Another column shows clearly the remains of giant sea snails and other forms of marine life.

Can You Invent It?



LET us suppose that the inventor of this device died before completing it—and you are required to finish his work. You know only that he was working upon a motion picture camera and that this is the part of the mechanism that must advance the film one "frame" between exposures, while the camera shutter is closed.

On examination, you find that the circular disk *D*, carrying the collar *E*, is soldered to the disk *C*, having the rounded projection *H*. This entire part, comprising *C*, *D*, and *E*, is fastened by the set screw *I* to the shaft *A*, and rotates with it. Shaft *A* is geared to the circular camera shutter. Every time shaft *A* completes one revolution in the direction shown by the arrow on *D*, the camera shutter also revolves once.

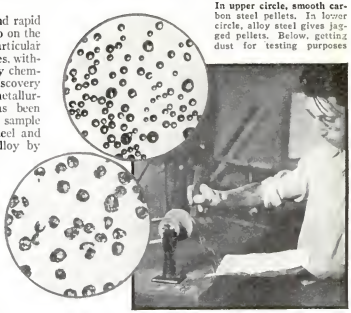
The part *F*, carrying the collar *G*, is fastened by the set screw *J* to the shaft *B*, to which the film sprocket *K* is also attached by the set screw *L*. When the device is in the position shown in the diagram, the camera lens is covered by the solid part of the circular shutter. Before the exposure-opening of the shutter is again brought in front of the lens, shaft *B*, carrying the film sprocket *K*, must be made to revolve one quarter turn.

What changes would you make in the mechanism as it stands in order to accomplish this result, and to insure that the film sprocket *K* continues to advance the perforated film one quarter turn for each complete rotation of shaft *A*? You can modify the parts *D*, *C*, and *F* in any way you choose, but the positions of shafts *A* and *B* cannot be altered. See scale pattern in illustration.

•

Watch this space next month for correct solution of this problem.

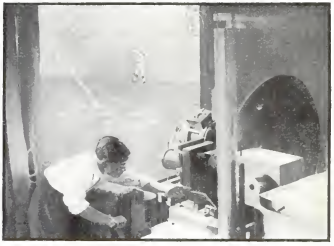
SPARK DUST IDENTIFIES STEEL ALLOY



In upper circle, smooth carbon steel pellets. In lower circle, alloy steel gives jagged pellets. Below, getting dust for testing purposes

AN INEXPENSIVE and rapid method of keeping tab on the kind of steel that a particular industry or factory uses, without resort to a lengthy chemical analysis, is the discovery of two Canton, Ohio, metallurgists. Hitherto it has been possible to hold a test sample against a grinding wheel and judge the type of alloy by noting the shape of the flowery sparks thrown off, but there are some alloys that cannot be identified without doubt by this test. One of the Canton experts suggested that the dust left from the sparks might aid in identification. They obtained a microscope and found he was right. Carbon steel yielded smooth black globules, while addition of chromium to the steel made the pellets grayish with a frosted surface. Spark dust from vanadium steel proved to be composed of shell-like pellets. Other alloys give different forms. The new test supplements the spark method, and, luckily, the very metals that fail to respond to the earlier test are the easiest to identify in the new way.

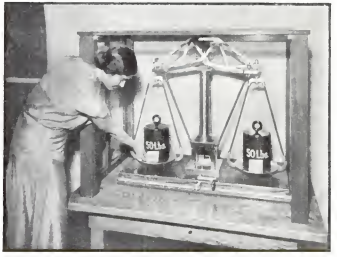
SEE BASEBALL BY RADIO



A BASEBALL game was viewed by television the other day at Tokyo, Japan. The apparatus, including a transmitting "camera" that would operate in daylight, was rigged up by Dr. Yakamoto of Waseda University at the edge of the baseball field. His students, gathered in the university laboratory, worked the receiver that brought them scenes of the game.

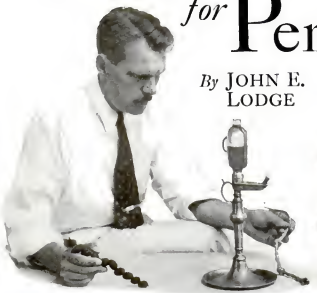
SCALE WEIGHS THREE PENCIL MARKS

THREE pencil marks proved sufficient to throw off balance what is said to be the most accurate heavy-duty scale in the world. This instrument, in use at the Lynn, Mass., meter laboratory of the General Electric Company, can weigh objects as heavy as fifty pounds. In the unusual test of its delicacy, the scale was first balanced exactly with a blank piece of paper and a fifty-pound weight on each of the pans, and then three pencil marks were made on one of the pieces of paper. The pointer swung over in response to an added weight of about thirty-five millionths of an ounce, corresponding to the extra load of the pencil mark.

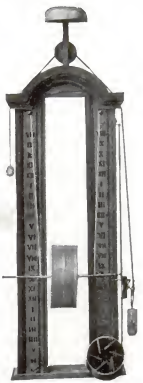


New Triumphs in Age-Old Quest for Perfect Timepiece

By JOHN E. LODGE



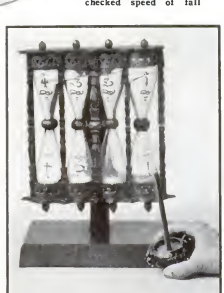
Three "fire-clocks." At the right is a rope with knots tied in it. The user set one end of it alight and noted the passing of time as the flame traveled between the knots. On the left is a palm oil nut clock that works in a somewhat similar manner, the first nut of the string being lighted and then the next. Burning of the entire string indicated a unit of time, while the individual nuts, as they were burned one by one, indicated passing of fractions of that time



This is an early alarm clock. The drum in center was partly filled with water and wound to top. As it fell, water flowed from one compartment to another, causing a rotation that checked speed of fall

At right, a sinking dish clock that was in use more than 6,000 years ago. A tiny hole in the bottom of the bowl allowed it to sink slowly when it was floated on a dish of water

Here is another water clock that was in use in Germany 300 years ago. Water was poured into a funnel and it escaped into cylinder at bottom. A float in this rose and moved the clock's hand



At left is an Alfred Candle which was really a fire clock, as the time was measured by the burning period between each number. It was crude and inaccurate. Above, on right, is a Chinese punk clock which was almost exactly like the Alfred Candle and could be no more reliable. Behind it is a battery hourglass built by a German to divide the hour into quarters

A CENTURY-old quest for a way to make watches keep good time in the face of heat, cold, and magnetic influences has just attained its end through the development of a remarkable new steel alloy.

Dr. C. E. Guillaume, head of the International Bureau of Weights and Measures, has produced the essential metal, which he calls "elinvar."

Use of the new alloy makes watches proof against the vagaries of the weather and magnetic disturbances, and also prevents rust and permits a more rigid and durable construction.

Elinvar is used only to make the hairspring, the tiny, hairlike coil you see in your watch contracting and expanding with the seesaw motion of the balance wheel.

This little balance wheel serves the same purpose in your watch as the pendulum in your clock. The pendulum is swinging back and forth against the pull of gravity. In the watch, the place of gravity is taken by the tiny hairspring's tension, against which the balance wheel swings back and forth.

Gravity, in a given place and at a given altitude, is constant. But the elasticity of most metals is not. It is upon the constancy of the hairspring's elasticity that the timekeeping quality of a watch depends.

The elasticity of any ordinary steel spring is affected by heat and cold. The spring is stronger in cold weather and weaker in hot weather.

Now, the secret of the new alloy is its immunity to heat and cold. At any temperature ever encountered by a watch, the elasticity of a hairspring made of elinvar remains constant.

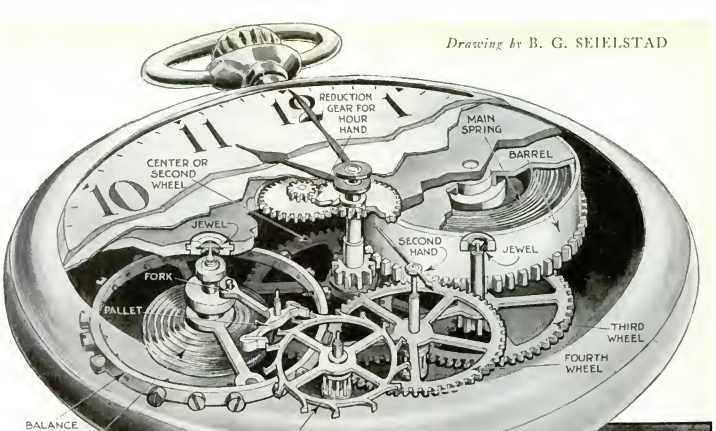
Since the balance wheel in a watch is really a modified form of the pendulum, it obeys the same laws. In other words, when the balance wheel expands as a result of heat, it swings slower, like a lengthened pendulum. When it contracts as a result of cold, it swings faster, like a shortened pendulum.

Take, for example, a dollar watch or a cheap alarm clock. They are fitted with an ordinary steel hairspring and a solid metal balance wheel. When heated, the hairspring weakens and the balance wheel expands. When chilled, the hairspring is strengthened and the balance wheel contracts. That is the reason such clocks and watches lose time in hot weather, and gain time in cold weather, sometimes as much as five to seven minutes a day.

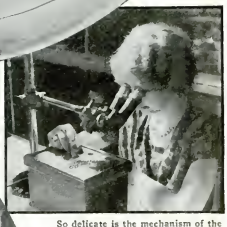
But the elasticity of the new alloy is not affected by temperature changes. On the other hand, it expands and contracts in size just as does ordinary steel. Hence, an elinvar hairspring automatically compensates for the expansion and contraction of the balance wheel, and keeps the watch running at the same pace no matter how hot or cold the weather.

Long before the development of elinvar,

Drawing by B. G. SEIELSTAD



This remarkable drawing of the works of a watch gives an idea of what goes on in your timepiece. The balance wheel, the escapement, the hairspring, the mainspring, and other parts are all clearly shown by our artist



So delicate is the mechanism of the finest watches that powerful glasses are needed in selecting jewels used

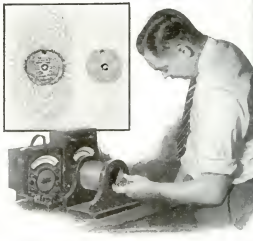
expert chronologists had found a way partly to compensate for changes in temperature, and if you own a fine watch it is sure to contain the embodiment of their ideas.

Pierre le Roy, the great French horologer, suggested the split balance wheel, which compensates itself. Thomas Earnshaw, an English expert, perfected it more than a hundred years ago.

Since that time, all good watches have had balance wheels with rims consisting of strips of brass and steel. The outer layer was made of brass and the inner layer was made of steel. Then the rim was split in two places. The unequal expansion of the two metals caused the rim to bend and the wheel to decrease in diameter. As the temperature increased, this arrangement partly compensated both for the natural expansion of the balance wheel and for the weakening of the hairspring's elasticity.

But the split balance wheel never was entirely satisfactory. The basic imperfection of the system lay in the fact that, no matter how accurately the brass and steel were put together, it was impossible to counterbalance the effect of normal heat expansion and loss of elasticity in all temperatures. Besides, the split wheel was necessarily delicate.

Because the new alloy compensates for the expansion of the balance wheel and does not lose any of its elasticity, there is no further need for Le Roy's split balance wheel in watches fitted with an elinvar hairspring; and the strong, solid, single-metal wheel, now found in cheap, "uncompensated" timepieces, again can be used in fine watches.



A watch, brought within a magnetic field seen at left above, can be repaired by slowly demagnetizing it as in the photo

If an ordinary high-grade watch is taken near any piece of electrical machinery surrounded by a strong magnetic field, it either ceases to keep accurate time or stops altogether. The reason is that the hairspring becomes magnetized and sticks to the balance wheel.

An expert watchmaker usually can remove nearly all the effects of magnetism from a watch by exposing it to a magnetic field produced by an alternating current and then slowly withdrawing it from this field, thus gradually weakening and finally almost eliminating the magnetism.

All this is unnecessary when a watch is fitted with an elinvar hairspring. Such a watch, too, will stop when exposed to a magnetic field, but the second it is removed from the field, the magnetism induced in the hairspring disappears and the watch resumes its ticking as though nothing had happened.

Finally, elinvar is nonrusting, and that does away with another source of trouble. Because of the threadlike size of the hairspring, a speck of rust no bigger than the point of a pin materially reduces the strength of the tiny coil and impairs the accuracy of the watch.

Nature supplied our earliest ancestors with crude timepieces. The rising and setting of the sun marked the beginning and the end of the day. The fact that the sun never rises or sets at the same time for two days running, and that the other natural timepieces were prone to similar errors, was no great handicap to primitive man.

But civilization brought complications. One of the earliest timepieces was a device, used by the ancient Greeks and Romans, to protect audiences from long-winded orators. To place a definite check on the flow of *(Continued on page 127)*

MORRIS' PARTY AT WORK
At right, the members of the Earl H. Morris Carnegie Institution party digging for relics in Broken Flute Cave, Arizona. Below, four of the 1,600-year-old ceremonial sashes found in the cave

Fabrics Woven 1,600 Years Ago

Found Unstained in ARIZONA CAVE

ON A day some time during the fourth century after Christ an American Indian, living in what is now Arizona, placed several beautiful wool sashes in a storage bin of his hut. They were among his chief treasures, for they had been carefully woven for him to wear during the religious ceremonials of his tribe.

The ancestors of this tribe, now called Basket Makers No. 3, had established their village on the floor of one of the great open caves that are occasionally found in the sandstone cliffs of Arizona and New Mexico. This cave was about 800 feet long by sixty to eighty feet deep.

When the advance scouts of the Basket Makers No. 3 came walking down a branch of the Ah-Tah-Ho-Nez canyon they saw at once that the cave was an ideal home site. Its floor was comparatively level, its great, curving, wind-scoured roof gave considerable protection from torrential rain, and the cave was far enough up the cliff to be defended against enemies.

As Basket Makers No. 3 multiplied, the number of their houses increased until there were at least fifteen of the round, earth-roofed, pole-and-mud-thatched huts.

Where Basket Makers No. 3 came from is still doubtful, but from the wonderfully preserved specimens of their handicraft which were discovered a few weeks ago by a party of archeologists under the direction of Earl Morris, of the Carnegie Institution of Washington, D. C., it is obvious that they brought with them a highly developed skill in spinning, weaving, and woodworking.

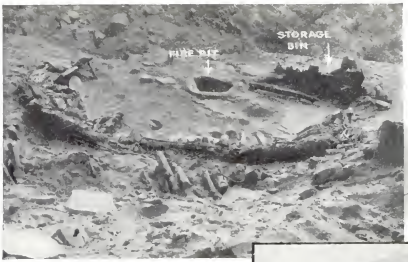
When, on that far-off day 1,600 years ago, our Basket Maker brave put away his ceremonial finery in the storage bin or "cist" of his house, he little dreamed that he would never wear those beautiful wool sashes again. Why he did not do so, we shall never know.

At any rate, the houses were destroyed by fire, and the earth on the roofs fell in, burying all of each family's domestic possessions.

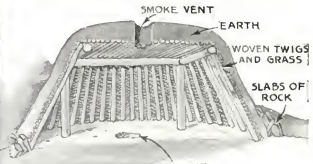
If this had occurred to a village built under the open sky, the rains of the succeeding centuries would have rotted away all evidences of the craftsmanship in weaving which Morris' party brought to light. But in the case of the huts that had been built far back under the curving roof of the gigantic cave, the rain could hardly reach them, and in the dry air of Arizona the earth dust that fell in upon the house of our Basket Maker remained dry and powdery—a perfect preservative.

THEN at last, after sixteen centuries, came the Morris party. One of Morris' assistants, carefully brushing the powdery dust out of the storage bin of a ruined hut, lifted the bundle of sashes, shook out the dust, and gave a cry of delight.

Morris took the sashes to the new Laboratory of Anthropology established in Santa Fe, N. M., through the aid of John D. Rockefeller, Jr. There the writer of this article saw the exhibits and photographed them for the first time for POPULAR SCIENCE MONTHLY.



At left, the circle roughly outlined by débris marks the wall line of one of the Basket Maker's huts on the floor of Broken Flute Cave. Below, a restoration of a Basket Makers home built of ruins found in big cave



Basket Makers' pottery was originally made over a woven basket, and the straw marks can be seen in these bowls

This Basket Maker when buried was wrapped in a feather blanket, now gone

Strange Remains of Early Americans, Including Pipe, Flutes, Pottery, and Shawls, Dug Out of Fine Dust, Are Shown Here for First Time

By GAYLORD JOHNSON

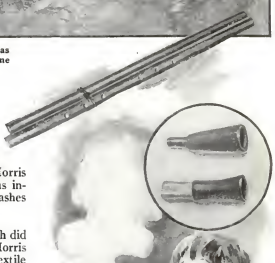
Morris found in the cave's débris fragments of two large bowls which seem to prove that the first pottery was made by molding wet clay upon the inner surfaces of large, shallow, finely woven baskets.

When the hut containing these particular bowls was burned the clay they were made of was fired and hardened. Morris thinks it possible that the firing of pottery may have been discovered in this way, after the burning of a dwelling containing raw clay utensils.

He also pointed out that the shape of the pottery jars made by the Basket Makers was copied from the squash or pumpkin which they cultivated.

Among the first objects uncovered by the Morris party were two flutes, made of box elder. These caused the great cave to be named Broken Flute Cave. The elder shrub used for the material of the flutes has a small core of pith in the center. In some way as yet unknown, this pith canal was enlarged to form the large bore of the wind instrument. The finish of these primitive flutes is amazing, considering the crude nature of the tools that must have been used to fashion them.

Among the most interesting exhibits shown the writer were two small objects looking exactly like modern cigar holders. These, Morris explained, were used as pipes, as was indeed obvious from the small cake of ashes still sticking in their bowls!

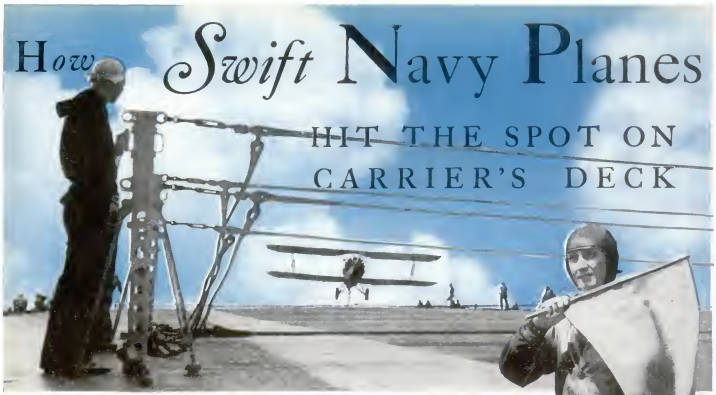


At top, two flutes made of box elder wood as they appeared when the covering dust was brushed away. In circle, pipes in use before America was discovered

SO WONDERFULLY new and fresh did the sashes appear that I asked Morris how the great age of this remarkable textile work could be established beyond a doubt. He told me that the half-burned logs from the Basket Maker huts in which the sashes were found had been referred to the "Tree Ring Laboratory" at Tucson, Ariz., and that the exact age of the houses was being determined by the method of comparing the annual rings of growth of these logs with others of known age secured from other sites (P. S. M., Sept. '31, p. 16).

When the tomb of Tutankhamen was opened a few years ago the amazing state of preservation of the articles found caused general wonder. In equally wonderful condition are the first textiles brought to light by the preliminary excavations in the Broken Flute Cave by the Morris party. Doubtless they will soon be followed by many other extraordinary finds, for after the meeting and conferences held at the opening of the Santa Fe Laboratory of Anthropology, Morris returned to the site in northeastern Arizona to continue the work of excavation. The location is in a branch of the Ah-Tah-Ho-Nez canyon so remote that he and his Navajo Indian workmen had to build a road in order to drive the automobiles and trucks to the camp.

How *Swift* Navy Planes HIT THE SPOT ON CARRIER'S DECK



NO CRASH POSSIBLE: As the plane comes in, a barrier of wire fences is raised on carrier's deck to prevent accidents and keep plane from smashing those parked on the deck

ON A small, square platform beside the ramp that overhangs the stern of the U. S. S. *Saratoga* stands the landing signal officer. Ahead, four city blocks in length, stretches the smooth deck.

The signal officer unfurls two yellow flags. Across the flight deck his "echo," an enlisted man with two more yellow flags, takes his post on a similar platform.

Occasionally the signal officer glances toward the bridge. White flag or red?

The giant carrier, now under way five minutes, slowly gathers speed as 180,000 horsepower pour out through her propellers. She turns into the wind and the two destroyers acting as plane guards change their course to take their positions on the flanks. The red flag is out. No landings yet. Speed increases to ten knots, eleven, thirteen, fourteen.

Off the port beam flies a lone airplane, a scout from the base at North Island, which is beyond sight over the horizon. High in the air hovers the plane like a bird of prey awaiting a chance to dig its talons into the teakwood deck.

Now! Out goes the white flag. She may land. The scout continues to fly off the port beam in a gradually narrowing left-hand circle, making for a point directly astern the *Saratoga*.

The landing signal officer, standing erect as the scout glides toward the ship, holds his flags horizontal. The scout's pilot, judging his speed and glide nicely, will soon drop down on the deck. The signal officer draws the right-hand flag across his neck. "Cut the gun," it tells the pilot. He cuts, down comes the plane's tail, the scout settles in the arresting gear, and stops within fifteen feet after its wheels touch the deck.

Quickly the secret apparatus below the flight deck releases tension on the cables holding the plane. Ahead, four sailors have lowered the double crash barricade, a pair of two-wire fences that lie flush on the deck when not in service. On rare occasions planes have destroyed themselves by running into the barricade, but other planes, parked ahead, have been saved by this simple device. The scout's pilot "revvs" up the engine and moves forward to a point amidship. There seven enlisted men run to the plane and quickly examine flying and landing wires and such other external parts as might be damaged in landing. Then the pilot takes off, with the carrier steaming directly into the wind to avoid side-drift once the plane is air-borne.

Less than a minute elapsed between the landing and take-off. From my station in the life net, which extends the length

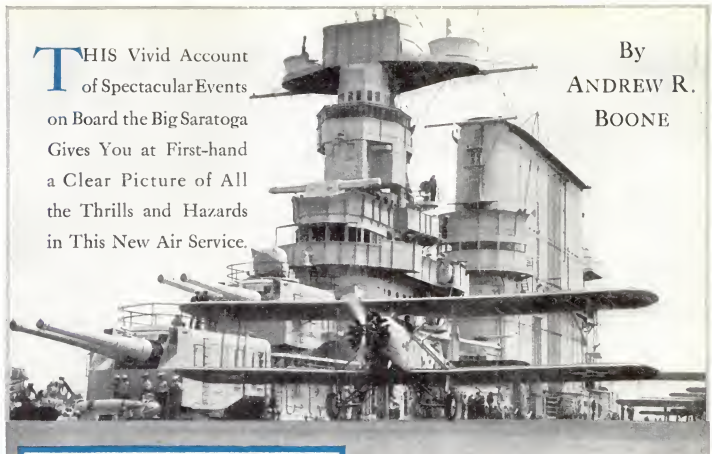
CUT THE GUN!

Lt. C. H. Duerfeldt standing on the carrier's deck, signals the flyer when to hit the spot. As he draws a flag across his throat he orders the pilot to "cut the gun" and land

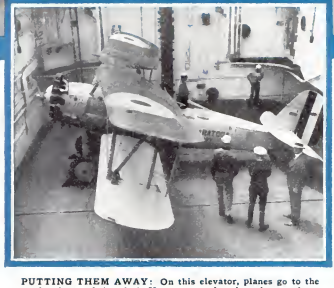
READY FOR FLIGHT: On the U. S. S. *Saratoga*, there is room for seventy-two planes parked with overlapping wings so that each can take off under its own power

THIS Vivid Account of Spectacular Events on Board the Big Saratoga Gives You at First-hand a Clear Picture of All the Thrills and Hazards in This New Air Service.

By ANDREW R. BOONE



HOME OF THE BROOD: And here is the huge mother ship of the flock of planes. This view of the *Saratoga* suggests its size



PUTTING THEM AWAY: On this elevator, planes go to the 400-foot hangar below deck. Here a scout plane is on its way down

of the flight deck to catch those who otherwise might jump overboard should some plane go wild, I could see the speed with which every man did his job to facilitate this "refresher landing" of a pilot who has done little carrier flying.

NOW here he comes again. And again. Seven times he landed, took off, circled close to the ship and flew in over the ramp. Each time the deck crew went through its action as quickly, but as nonchalantly, as flying field attendants ashore would aid an airman.

In the hands of the landing signal officer rests the great responsibility of telling these pilots how and when to land. At close range in some types of planes pilots can see little of the flight deck. Often he sees only the signal officer and his little flags. But the latter views the plane in its relation to the wood and steel landing field, and orders the approaching pilot to slow down, come in faster, pull away, or "cut!"

As I watched Lieut. C. H. Duerfeldt, landing signal officer aboard the *Saratoga*, wave whole squadrons of scouts and bombers aboard, I could understand the vital necessity for discipline among carrier pilots. To save their own lives, they must obey the signal officer's directions.

He does not order approaching pilots to take any particular course. He merely informs them by various flag signals of the position and condition of their planes. If his arms are horizontal, they're coming in properly. If the left flag is horizontal and the right flag down, they're coming in too fast, and the pilot must correct his speed.

Two orders are orders, however. When the signal officer wipes a flag across his throat, the pilot *must* cut the gun; otherwise, he may fly into the planes massed on the forward deck or fly into the "island," the superstructure on the port side amidship. This has happened on a few occasions. If the signal officer waves the pilot off, he must pull up and fly away or suffer the consequences.

"We demand prompt obedience," Duerfeldt shouted above the roar of the engine as the wings of a bomber, a lumbering crate that carries a ton of bombs, swept overhead after he had waved the pilot away. The bomber pilot had obeyed, but we ducked as the big ship flew away to begin another circle for a second try.

MEANWHILE other planes of the squadron landed in rapid succession. So closely did they fly that it seemed one might pile in on its predecessor before it could escape the arresting gear and move forward.

The lighter planes, especially the fighters, have enough power in their 450-horsepower engines to get away if they find themselves in trouble when landing. Consequently, the fighter pilots come in astern after completing their circle with much shorter runs toward the deck. The heavier scouts and bombers, carrying larger bomb loads and from two to five people, take fairly long, level runs toward the deck in order to get steadied away.

How unlike this is from flying ashore. There you circle a large field that remains stationary, glide into the wind, and alight on a runway possibly a half-mile long. Here the pilots dash in toward a landing field, hardly longer than 100 yards, that is moving away from them at a speed of fifteen to thirty miles an hour, generally light within the first fifty feet of this area, and permit their plane to settle only when some one on deck gives the order!

A tiny spot on the sea! Yet only one officer has been killed during the 10,681 landings made to date on the *Saratoga*.

How does it feel to seek out this sea-

THE MAKE-READY: Men at work hammering home pins and bolting wings of a plane together

going flying field that looks little larger than a postage stamp from the air?

Between landings, Duerfeldt told of the thrill that comes once—and sometimes several times—to every naval aviator. He, in common with all other carrier pilots, had completed the advanced training course at Pensacola, Fla., and reported to the battle force for carrier duty. On a field near San Diego, Calif., he had practiced one hour on each of three days landing within an area marked out on the ground to represent the after-deck of the *Saratoga*.

That is the beginning of each pilot's carrier training. He must land within the flag-marked boundaries approximating the space aft of the barrier. A lime-outlined circle close by the near edge helps him to judge his landing spot. This is called "spot landing."

Ashore the pilot learns not only to "hit the spot," but he also acquaints himself with the flag signals. Therefore when, a few days later, he reports by air aboard his carrier he is qualified to bring his plane—possibly wavering a bit—down on the ramp.

Impressions? Most pilots have no impressions of their first carrier landing.

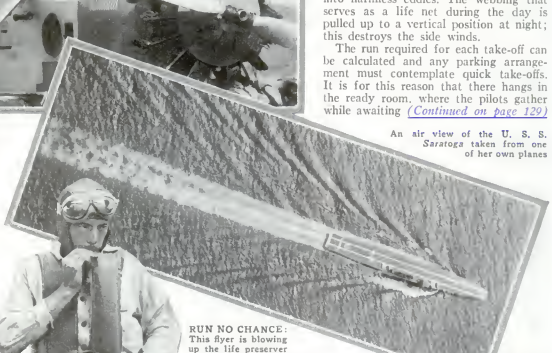
"On my first," Duerfeldt said, "when my fighter finally stopped, I didn't know just how I had got aboard. I merely obeyed the signal, believing that what I had been told was true.

"The majority of the pilots have the same experience during their first three or four landings. Gradually they acquire familiarity with the ship and soon come to regard the carrier landings as only another incident in their flying routine."

When the planes take off, sometimes after a run of only one hundred feet or so, one might get the impression that these are as casual as take-offs from an airport. Carrier take-offs, however, are founded on a scientific study of several elements, particularly the carrier's speed at the moment, speed of the wind blowing down her deck, size of the plane and power of her engine, and the load in the airplane. Even though the flight deck be jammed with planes, when the "call to arms" sounds there must be adequate room ahead for the fighters to take off.

The planes are packed with wings overlapping, filling every foot of space. At night those on deck are protected from the wind by wind-breaks, or "palisades," that break up strong head winds into harmless eddies. The webbing that serves as a life net during the day is pulled up to a vertical position at night; this destroys the side winds.

The run required for each take-off can be calculated and any parking arrangement must contemplate quick take-offs. It is for this reason that there hangs in the ready room, where the pilots gather while awaiting *(Continued on page 129)*



An air view of the U. S. S. *Saratoga* taken from one of her own planes

RUN NO CHANCE: This flyer is blowing up the life preserver each pilot must wear

WAITING FOR THE SIGNAL: In this room the pilots await their "call to arms." Here hangs a large board showing how many planes will fill a given area and how to park them

Mile-a-Minute on a Bobsled

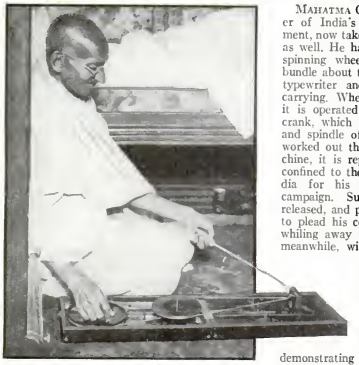
At top, a two-man bobsled team taking one of the dangerous curves of the new Lake Placid course. Note canvas shield to keep the sun from softening the ice. Above, champion four-man Red Devil team that holds world's record for bobsled speed

ENGINEERS are putting the finishing touches to the mile-and-a-half bobsled run at Lake Placid, N. Y., and in a few weeks the world's crack bobsled teams will pit their skill in one of the most thrilling and dangerous of all sports. Spectators at the Third Olympic Winter Games next February will see four helmeted and begoggled figures, padded as for football, hunched upon a sled at the mountain top. When a lookout signals "All clear" on the course and a bugle blows, they'll start. Powdered ice will spray from their grinding runners as they swish around a turn at sixty-five miles an hour—for mile-a-minute speeds are common at some points on the track. Only one racing team uses the course at a time, and the team that reaches the bottom in the fewest number of seconds is the winner. At present the champion "Red Devil" racers of Saranac Lake, N. Y., hold the world's record of one minute and fifty-two seconds for the mile-and-a-half run. The Lake Placid course, designed by Stanislaus Zentzytzki, a German engineer, is called the only scientifically constructed bobsled run in America and the only one of its kind in the world. New York State built it last year in preparation for the Olympic games this winter. An average drop of ten percent gives the sleds terrific speed. Water from a storage reservoir sprinkles the run to give a surface of glare ice.

ENGINEERS BUILD TRACK

Above, in grading the curves a bobsled is used by engineers to find out how racers will take the turns. Note track is built of rock with wooden ribs. At left, a survey is made of a curve blasted out of the solid rock

Gandhi Invents Spinning Wheel



Mahatma Gandhi, leader of India's independence movement, and portable spinning wheel he invented for use on trips

MAHATMA GANDHI, famous leader of India's independence movement, now takes rank as an inventor as well. He has devised a portable spinning wheel that folds into a bundle about the size of a portable typewriter and has a handle for carrying. When unfolded for use, it is operated by turning a small crank, which runs the two wheels and spindle of the device. Gandhi worked out the details of this machine, it is reported, while he was confined to the Yerwada jail in India for his "civil disobedience" campaign. Subsequently he was released, and proceeded to England to plead his country's cause there, whiling away the shipboard hours, meanwhile, with his new machine. He advocates return to such home industries as spinning to solve India's economic troubles. The photograph at the left shows Gandhi demonstrating how his spinning apparatus is operated.

THIS REAL GOLD BRICK IS WORTH $30,000

LEGENDARY has become the gold brick of days gone by, a gilded imitation of the precious metal, used to swindle the gullible. But New York stock brokers blinked their eyes, the other day, at a genuine gold brick of solid metal. Brought back from Alaska by Ben Smith, a trader, it is valued at $30,000. The unusual souvenir was recently placed on exhibition at the New York Stock Exchange, protected by guards. It weighs 1,500 ounces troy, or more than a hundred pounds.

USE GRAVITY PULL TO GAGE PLANE'S ALTITUDE

SCIENTISTS have known for years that the pull of the earth's gravity diminishes as an airman rises above it; thus, a 150-pound man who rose in a balloon to 52,000 feet, the present altitude record, would lose about three quarters of a pound in weight. But it has remained for a twenty-six-year-old Viennese engineer, Hans von Braun, to put this principle to use in an entirely new type of altimeter, or height indicator, for aircraft. He has perfected an electric instrument which, by measuring gravity's pull, is said to give the exact height of an airplane from the earth at all times. Even blind flying in a fog would be safe with this instrument, according to the inventor, since it will tell the pilot if he is passing over a mountain. Present-day altimeters use a barometer to indicate altitude, in terms of air pressure, which is somewhat variable and uncertain and at best cannot warn the pilot of mountains or other obstructions.

Hans von Braun, right, with his altimeter that gages plane's altitude above earth by measuring force of gravity

STREAMLINE MOTORCYCLE TO GET 170-MILE SPEED

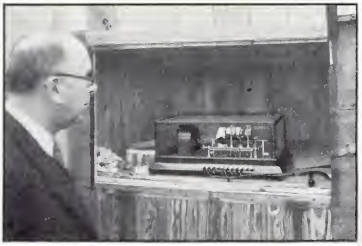
THE last word in streamlining is a grotesque motorcycle recently tried out in England. Designed to set a new world's speed record, its engine and handlebars are sheathed in tapering metal coverings. The rider even wears a streamlined cap to offset the wind resistance of his head. The saddle of the machine is so placed and the rider's position so arranged that air resistance is reduced to a minimum. Named the Silver Comet, the machine was expected as this issue went to press to attain speeds of 170 miles an hour. Its rider, Joe Wright, already held the existing world's record of 150 miles an hour.

Streamlining even to the rider's head is accomplished in this new motorcycle on which an effort will be made to go 170 miles an hour

FAST VIBRATIONS GIVE SOUND THAT HIDES

A "SOUND that hides," recently demonstrated by General Electric engineers, fills a room but seems to come from nowhere in particular. It is emitted by a tuning fork vibrating 1,000 times a second and giving a pure musical note. It seems to come from all directions at once, because the sound sets up "standing" or apparently stationary waves by reflection from the walls. An ordinary sound such as that of a buzzer is easily traced to its source by turning the head, because it does not create standing waves.

MAP WINDS FOR OCEAN AIR LINERS



At right, mast equipped with wind instruments near Washington; and above, reading the data thus gathered in room near foot of mast

In an abandoned flying field near Washington, D. C., men recently erected a spindle-legged steel tower that might have passed for a windmill or a transmission pole, save for a weather vane and a small spinning instrument at the top. Few know that this and similar towers in three other cities of the Atlantic seaboard are helping to bridge the Atlantic by air. Erected by a firm that is planning a transatlantic Zeppelin line, they reveal the prevailing direction and force of wind at each point. This information will help experts to decide whether the best airship terminal on this side of the ocean is to be found at the Washington site, at Philadelphia, Pa., at Baltimore, Md., or at Richmond, Va. Abroad, a terminal for the proposed line is already being built at Friedrichshafen, Germany. Developments such as this indicate that the long-discussed project of a passenger air line across the Atlantic is on the point of being realized. More than 500 imaginary flights made by Zeppelin experts "on paper" confirm this idea. From Government weather maps giving daily conditions for the last five years, the engineers determined what sort of weather airships would have encountered had one left Paris for Washington every Saturday night. Two investigators tackled the problem of selecting a course for the ship during Sunday and Monday with the aid of one day's weather map at a time. Eastbound flights were also plotted.

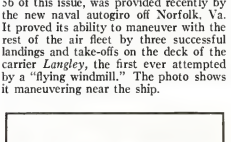
The investigators found that a schedule of from fifty-eight to eighty hours could be maintained at least eighty percent of the time, summer and winter. Other trans-ocean projects are already under consideration, among them a transpacific dirigible line to carry passengers between California and Hawaii, and ocean airplane lines using floating islands or "seadromes" as midway stops. The groundwork for these lines is now being laid by the British and American navies. Last spring the British navy issued the first comprehensive chart ever made of upper air conditions over the oceans, which it obtained by sending up testing balloons from forty warships. Now the U. S. Navy has assigned a trained aerological officer, Lieut. R. H. Smith, to take charge of a more exhaustive survey.

LOUDSPEAKERS DIRECT TRAFFIC

Loudspeakers helped direct traffic in a recent experiment at a Houston, Texas, street corner. From a bay window overlooking the corner, an announcer delivered admonitions to jay-walkers and assisted the regular traffic officer at the intersection in controlling traffic. His booming voice issued from horns on a metal awning over the sidewalk. A sound truck, parked near the corner, supplied electric power for the apparatus. A week's use of the loudspeakers was said by traffic officials to have shown marked results in educating the public to traffic safety.

AUTOGIRO LANDS ON BIG SHIP'S DECK

An innovation in the doings of the Navy's aircraft carriers, described on page 56 of this issue, was provided recently by the new naval autogiro off Norfolk, Va. It proved its ability to maneuver with the rest of the air fleet by three successful landings and take-offs on the deck of the carrier *Langley*, the first ever attempted by a "flying windmill." The photo shows it maneuvering near the ship.



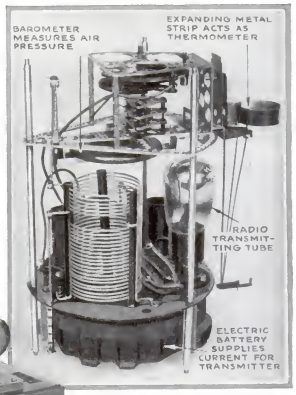
SUNSHADES FOR TREES CAUSE RAPID GROWTH

Sunshades for trees have made their appearance in Germany. Made of close-woven netting on a wooden framework, the shades are placed on the south side of a group of young trees at a railway station near Berlin to guard them from the scorching rays of the noonday sun. Evidently the scheme works, for the trees are said to have shown unusually rapid growth. Similar shields keep the sun from melting the ice on the Lake Placid bobsled run (see page 59).

Radio Feeler for *Akron* Gives Weather Report to Aid Ship's Landing

Above, radio feeler lowered through fog reports if air below is clear. At right, the receiving instrument that records "feeler's" report of weather conditions

WHEN the Navy's newest and biggest airship, the *Akron*, comes down through a fog bank, a radio "feeler" will tell her skipper whether the air is clear below and a landing can be made safely. This robot instrument, dropped on a cable through the fog, automatically broadcasts information about humidity, temperature, and air pressure. A radio receiver in the airship's cabin instantly records on paper the feeler's report. The radio feeler is an adaptation of an instrument designed by a Russian, Prof. Moltschanov, and intended to be attached to an eight-foot balloon and sent aloft to broadcast conditions in the upper air. This remarkable instrument houses in compact space a thermometer composed of two metallic strips fastened together, a tiny barometer, a hygrometer for measuring moisture, and a radio set complete with batteries for automatically broadcasting the readings of all three. The *Akron* will receive information by radio because it is simpler to get data that way than to make electrical connections. Several of these instruments were sent up with balloons by the German airship *Graf Zeppelin* to study Arctic air conditions (P.S.M., Oct. '31, p. 29). Now the U. S. Navy has ordered two instruments to aid in perfecting the radio feeler.



Removing the case of the radio feeler, above, reveals a compact radio broadcasting station

FLYING TAUGHT IN PLANE ON CABLE

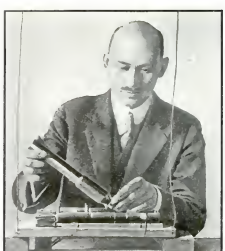
Strung on a thousand-foot cable between fifty-foot poles, this plane flies but can't crash

STUDENT flyers can now take the stick in a plane that actually flies and yet be safe from any danger of crashing. The plane is attached to a cable strung between two fifty-foot poles one thousand feet apart. The propeller drives the plane along the cable in real flight but cannot escape, as it is limited to the run between poles. A second cable keeps it from striking the poles. Motive power is provided by a four-cylinder motor.

SISTER SHIP OF *DO-X* BIGGEST IN THE WORLD

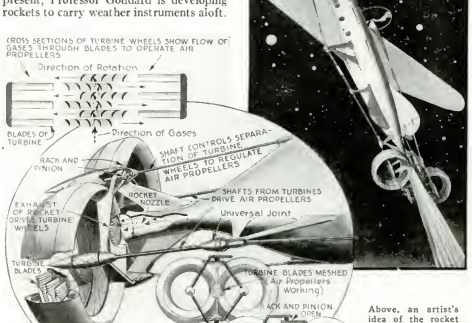
IF YOU thought the photograph seen below showed the giant *DO-X* flying boat which arrived in America not long ago, take another look. Not everyone knows that the giant Dornier plane has a sister craft, the *I-REDI*, also constructed in Germany. This recent photograph was snapped just after it arrived at La Spezia, Italy, to be turned over to the Italian government. The new monster is almost an exact copy of the *DO-X*, and is understood to be a shade larger. If this is true it, and not the *DO-X*, is the largest heavier than air craft in the world. Its trial flights have proven its lifting power and serviceability in the air.

Rocket Turbine Will Drive Sensational High Speed Plane



Prof. Robert H. Goddard, of Clark University, conducting a rocket test in his laboratory

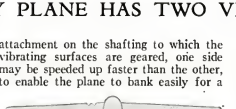
THE first airplane designed to be driven by a rocket turbine has just been patented by Prof. Robert H. Goddard, noted rocket experimenter of Clark University, Worcester, Mass. When this strange craft flies near the earth, exhaust gases of a rocket impinge directly on the heat-resisting metal blades of two turbine wheels. Their spinning drives a pair of conventional air propellers and supplies the motive power for the plane. On climbing to higher altitudes, however, the pilot operates a rack-and-pinion device that partly or completely withdraws the turbine blades from the path of the hot gases. This disconnects the air propellers, which would be useless in the thinner air, and allows the craft to be propelled by the "kick" of the rocket blast itself. At low altitudes, Professor Goddard points out, most of the heat energy in the rocket fuel is wasted in ejecting the exhaust gases at a uselessly high speed. His rocket turbine, explained here in diagrams based on his patent specifications, would recapture the energy of the stream of gas. Such an airplane, devoid of the conventional gasoline motor and driven by rocket power, might be capable of high speed voyages in the thin upper air or even of voyages outside the earth's air to the moon and beyond. On this page and on our cover our artists illustrate the sensational possibilities of such an aircraft. At present, Professor Goddard is developing rockets to carry weather instruments aloft.



Above, an artist's idea of the rocket turbine plane flying through space. At left, diagram based on Goddard's patent drawings shows how plane is expected to function

NEW DRAGON FLY PLANE HAS TWO VIBRATING WINGS

PATTERNED after a dragon fly is a remarkable airplane which H. H. Smith, of Vashon Island, Wash., is building. Behind a pair of wings of conventional mounting is a set of vibrating ones. Their motion, according to Smith, will pull air backward over the fixed front wings and add to the lift of the plane. By a clutch attachment on the shafting to which the vibrating surfaces are geared, one side may be speeded up faster than the other, to enable the plane to bank easily for a turn. Another radical departure from usual practice is the shape of the fixed wings' cross section, which consists of curves with a depression like a gutter near the leading edge, also to increase lift.



Horace H. Smith, builder of the dragon fly plane, points to unconventional curves of fixed wings. Diagram gives position of fixed and vibrating wings

1,900 GLIDER FLIGHTS ON $5.70 REPAIR BILL

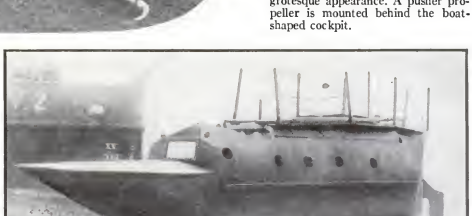
THOUGH more than fifty inexperienced students flew it, the repair bill for one glider during a whole year totaled only $5.70, a Florida instructor reports. The machine was of the "primary training" type used for beginners. More than 1,900 flights were made in it during the year. Many of them reached an altitude of 350 feet, and 200 of them were made at night in an eighteen-mile wind. Yet the most expensive repair, costing $3.35, was the result of an accident on the ground, when the unattended glider blew over on its back and damaged wings and rudder. A minor crash while an auto was towing the glider broke a link holding one of the bracing wires, and occasioned the least expensive repair of the year's operation—ten cents for a new link.

Use Bicycle Handlebar to Steer Remarkable German Plane

How far German experimenters have gone in a search for new airplane designs is shown in this remarkable craft, recently tested in the Wasserkuppe mountain region where glider flyers congregate. This machine, however, is designed to fly under its own power. The pilot operates the forward-placed elevator by a control resembling a pair of bicycle handlebars. Zigzag tail surfaces and clawlike skids beneath the forward part of the plane contribute to its grotesque appearance. A pusher propeller is mounted behind the boat-shaped cockpit.

SEA-GOING SHIP BUILT ENTIRELY OF SCRAPS

When two unemployed Austrians of Vienna decided to emigrate to Abyssinia, they lacked funds for the voyage—so they constructed a homemade vessel. This strange craft, christened the *Nautilus II*, was the result. It was built entirely of scrap iron and other waste materials. At this writing its sea-going capabilities were awaiting trial. The builders insist that nothing was bought for the strange craft, not even the engines with which it is powered. They also claim credit for originating the peculiar design, which they are confident will prove seaworthy. The queer boat, seen at right, somewhat resembles a submarine in appearance.



SLASHED TIRES WIN PIKE'S PEAK RACE

C. A. Myers winning Pike's Peak race; at right, his cross-slashed tire and his rival's grooved tire

By slashing oddly placed grooves in their tires, two contestants recently beat all existing records for the famous automobile race to the summit of Pike's Peak, Colo. To avoid skidding and serve as cleats to give his wheels better traction in the loose gravel, C. A. Myers, the winner, cut channels across the tread at equal intervals around the wheels. He won in the record time of seventeen minutes and a few seconds, half a minute better than the previous record. The former champion, Glen Schultz, was only fifteen seconds behind the winner. His tires were grooved with channels all the way lengthwise around the circumference. Both cars were of unconventional design, the winning one equipped with one carburetor for each pair of its eight cylinders. In the thirteen-mile Pike's Peak course, the cars climb 5,000 feet.

FOLDING FIRE ESCAPE IS METAL LADDER

Extended, this novel fire escape becomes a substantial metal ladder to the ground, but it takes up little space when folded. It was designed by a British inventor, and is intended to be slung from a bedroom window in an emergency. Angle irons are fastened securely to the vertical members of the ladder at regular intervals along its length to provide hand-holds for unfolding it and for descent.

This fire escape, which is collapsible, is seen below partly folded and in part extended

Flyers Drift at Sea on Hull of Plane for 158 Hours

WHEN a transatlantic plane hops off and is never heard from again, what happened to the flyers? This remarkable photograph helps the imagination fill the gap. It shows the wrecked airplane in which Willy Rody, Christian Johannsen, and Fernando Costa Viega hopped off from Portugal, down in the sea ninety miles off the Newfoundland coast, with both wings smashed and the hulk barely afloat. Faced with death by starvation or exposure, the men drifted atop the partly-submerged plane or rested in its flooded cabin for 158 hours, drinking water drained from the engine's radiator to allay their thirst. Luckier than many aviators forced down at sea, they were sighted by a passing ship and rescued. A photographer aboard the rescue vessel snapped this view just before the men were taken off the wreck and brought to New York.

WATERY GRAVE FOR WILKINS' SUB

THE career of the United States submarine *O-12*, renamed the *Nautilus* and used by Sir Hubert Wilkins in an unsuccessful attempt to reach the North Pole under Arctic ice, ended a few weeks ago when the U. S. Shipping Board granted Wilkins permission to sink the vessel in the North Sea. Misfortune had pursued it since the Navy, which had intended to scrap it, lent it last year to the Wilkins expedition. During the winter it was remodeled, and scientific instruments, drills designed to cut manholes through the ice from below, and runners for gliding under the ice were installed. But engine trouble developed in the transatlantic crossing en route to Norway, last summer, and a Navy battleship towed the submarine most of the way. Mechanical ailments dogged the red-and-gray *Nautilus* all the way to Tromsoe, Norway, the intended starting point of the Polar dash. Sir Hubert abandoned his transpolar project, but ventured out on an exploring voyage around Spitsbergen. With broken diving rudders, he essayed a trip beneath the fringe of Polar ice. Occupants of the vessel described the experience as harrowing. With the depth gage showing thirty-three feet, the submarine bumped along the bottom of the ice floe. Through portholes, the men saw threatening teeth of ice by the dim purplish light that penetrated the depths, and strange black fish swimming among them. A rending crash signified that the forward ice drill, on which the voyagers depended for escape in an emergency, had been shattered. Chunks of ice gouged and nicked the propellers. Finally the *Nautilus* emerged and struggled to port—so battered, in its commander's opinion, that it could never survive another similar attempt or a second transatlantic crossing.

BALLS SHARPEN RAZOR

SIMPLEST of razor sharpeners is this new device, composed merely of two steel balls in a loop handle. The blade is given a keen edge, according to the maker, by drawing it several times between the balls. Free to rotate, they constantly present a fresh grinding surface. The balls are not attached to the broken ring and can be replaced if lost.

CLOCK HAS NO FACE

A CLOCK that tells a car driver the time much as a speedometer tells the speed has been invented. The new clock gives the time in hours and minutes; one dial shows hours and the other minutes. The clock will fit above the auto's windshield.

NEW TRIANGLE PLANE IS TAILLESS

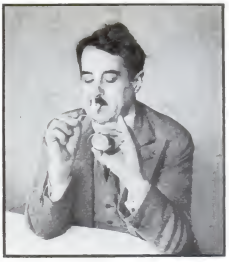
AN AIRPLANE demonstrated recently at a Berlin airport looks as if its tail had been amputated. Actually it never had any. Consisting solely of a pair of triangle-shaped wings, it is stable in flight, according to Capt. Hermann Koehl, transatlantic flyer, who directed its construction. The tailless "triangle plane" amazed engineers by scudding over the field at ninety miles an hour on the power of its baby thirty - horsepower motor. This had been added after the craft was originally designed as a glider. A "pusher" propeller is mounted directly behind the small cockpit. Since there is no tail on which to place a rudder, the craft is steered with vertical flaps installed at the ends of the wings. Experts who witnessed the demonstration predicted that it might profoundly affect the future design of light airplanes.

At left, the new triangle plane that has no tail; and, above, flying ninety miles an hour

SCOTLAND GETS INCLOSED FIRE ENGINE

Edinburgh firemen are shielded from winter winds when dashing to fires in this inclosed car which has outside attachments for hose and carries ladder

TO PROTECT its firemen from freezing winds on the way to winter blazes and back, Edinburgh, Scotland, recently acquired this buslike fire engine for use in the suburbs. Its completely inclosed body also averts the danger that a fireman may fall off the speeding car. Hose connections are provided on the sides of the machine. A telescoping ladder is carried on the roof of the unusual fire engine.



MATCHES ON RIBBON

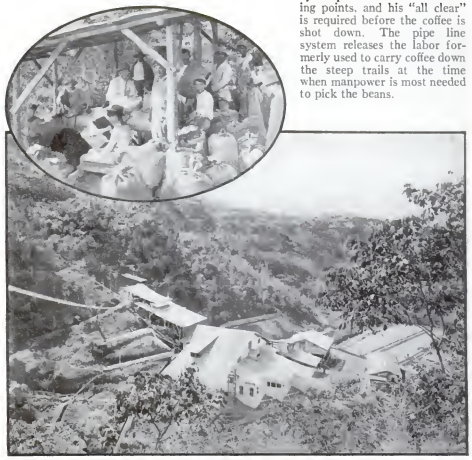
Now paper matches come in a ribbon. A German inventor has devised a pocket container that holds a roll of the matches, so arranged that when one is pulled out it automatically lights.

PIPE LINES CARRY COFFEE FROM MOUNTAIN TOP

WHILE coffee has been transported by pipe line before, one of the most elaborate systems of its kind was recently established by an American planter near Santa Marta, Colombia. The coffee is grown high on the foothills of the snow-capped Andes. Instead of carrying the beans down from these plantations on foot and muleback, natives bring them to the loading points for a spider web of pipe lines, leading to the mill in a valley far below. The pipes, made of telescoping sections of galvanized metal, resemble household rainspouts, but are more than twice as large. They cross ravines on trestles, with a constant down grade. Through these pipes swirl the coffee beans, carried along by a stream of water. A "chief dispatcher" is in constant communication by telephone with all the loading points, and his "all clear" is required before the coffee is shot down. The pipe line system releases the labor formerly used to carry coffee down the steep trails at the time when manpower is most needed to pick the beans.

MOVING PICTURE HELPS DENTIST AND PATIENT

PAINS in a dentist's chair are forgotten as the patient's interest is captured by a moving picture thrown on a screen directly in front of the sufferer. Dr. A. G. Highgate, of Wauconda, Ill., got the idea that a movie would be a relief for his patients, especially the children, and he had a small portable projector installed. Through this film is run while he is at work. As a result, he says, he finds it easier to give his treatments and decidedly less trying for his little patients. Older people are now asking that the pictures be shown while they are in the dentist's chair. Short comedies of the animated cartoon type are enjoyed the most by the children who come to him for treatment, Dr. Highgate reports.



In oval, coffee goes into a pipe line at a mountain top loading station when dispatcher signals "All clear." Above, one of the main pipe lines to this mill is seen at the left

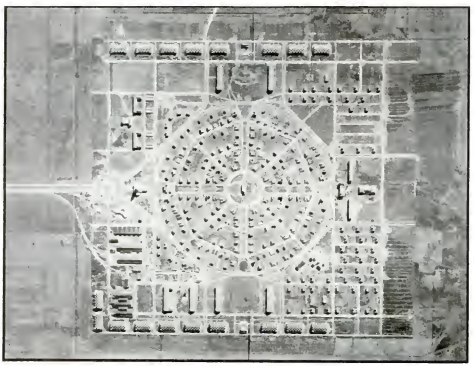
AKRON GETS PORTABLE WEATHER MAST

A WEATHER mast that can be wheeled about to check wind velocities and other conditions at various altitudes near the ground has been constructed for use at the airship dock in Akron, Ohio, where the Navy's new giant of the air, *Akron*, was built and has been moored pending the necessary trial flights before final delivery to the Government. With it a study of meteorological conditions in the vicinity is being made. Also, before airship take-offs and landings, it is used to determine the direction and intensity of air currents past the dock. Supplementing the portable mast is a similar structure permanently mounted on top of the airship shed. Combining the results secured by the two masts gives a complete check on weather conditions at the port.

Above, the portable weather mast at Akron; and at right, receiving the data gathered by it

FLYING CITY NOW TEXAS LANDMARK

A LANDMARK that cannot be mistaken from the air is the flying city that the Army Air Corps has completed at Randolph Field, near San Antonio, Tex. Its almost perfect geometric design recalls the walled cities of the Incas and even more ancient peoples, yet it is adapted to ultra-modern needs. Landing fields flank the city on all four sides, giving an approaching pilot his choice according to wind direction. Three hundred buildings, laid out in a regular pattern, occupy the 2,000-acre plot. A single highway and railroad connect it with the outside world.



A flying city at Randolph Field, near San Antonio, Texas, recently completed for the Army Air Corps, is geometrical in design with a landing field on each of its four sides

LEVER IN AUTO'S ROOF WORKS NEW SPOTLIGHT

A COMBINATION spotlight and turn warning, operated through the roof of a car, has just been devised by a Minneapolis, Minn., doctor. The spotlight may be swung clear around for backing, or pointed at any part of the road, by a slight turn of the lever which projects through the car roof. A ratchet arrangement holds the spotlight in any set position. To warn following motorists of a turn, the driver swings the vertical post either right or left and a red arrow automatically lights to point the direction.

New Army Air Corps winter suit designed to prevent affliction called "pilot's belly"

BELT PREVENTS "PILOT'S BELLY"

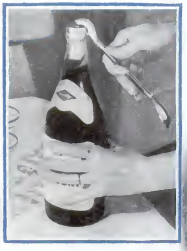
JUST as Paris fashions point the way to the rest of the world, so do the outfits worn by aviators indicate the trend of modern style. Within the last year, U. S. Army flight surgeons have been studying a new condition known as "pilot's belly" that indicates the need for a fairly wide belt to support and protect the flyer, much after the fashion of the belt worn by polo players. The motion of a plane in a dive or a zoom has an undesirable effect on some aviators. To correct this is the aim of the new Army Air Corps winter suit, a model that fits into the latest conception of comfort.

WHITE TYPE ON BLACK IS HARD TO READ

IF THIS magazine were printed with white letters, on a black background, it would take you ten percent more time to read it. A recent survey undertaken by two University of Minnesota investigators showed this difference in ease of reading between black on white and white on black backgrounds. Two hundred and eighty students were subjects in the test, which was made to determine the effectiveness of advertisements printed in white on black.

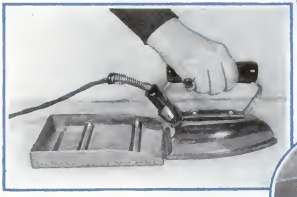
HANDY AIDS for

BATHTUB ACCESSORIES. Anything you want out of the medicine chest is within easy reach if your tub is equipped with this cabinet which is a combination of chest, seat, and mirror. When the door is lowered it is a seat with a strong metal frame, the back of which contains a mirror



DECAPPER AND SPOON. This combination tool is expected to save you steps as it is decapper and spoon all in one. The long handle makes it ideal for stirring the contents of a deep glass

YOUR EGGS ARE SAFE. A Los Angeles woman invented this drawer to keep her eggs from being broken. It has cuplike depressions in the bottom into which the eggs fit snugly



PUSH, DON'T LIFT. Two easily working rollers built into the bottom of this iron stand turn at the slightest pressure and the iron rolls easily onto it

BOTTLE OPENER. A new stainless steel kitchen fork has a notch near the handle that opens bottles

HOLDS THE SPOON. At right, an ingenious contrivance, shown in Paris recently, that fastens to pot's rim to hold spoon

SLICES ALL THE SAME. This simple kitchen tool is a knife for slicing fruit or vegetables provided with a guide so slices are uniform

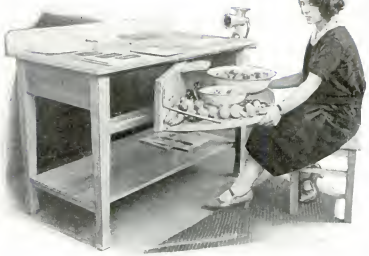
IT STAYS WHERE PUT. Rugs made with a backing of rubber do not slip or curl up, according to the manufacturer

TABLE OR SETTEE? At upper right is what looks like an attractive table and nothing else. In reality it is quickly transformed into a settee, merely by dropping the table top down as at right and exposing upholstered seat and back

Homemakers

A CONVENIENT DRIER. In a home where space is at a premium, this folding drier should be helpful. Its eight arms, which open out from a main support resting on three feet, will hold a considerable amount of clothes

VEGETABLE TABLE. Simply turning one knob swings this worktable, below, out so that it can be used comfortably while you sit on a chair. If work is interrupted, the table will swing vegetables quickly out of sight

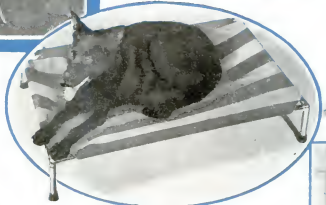


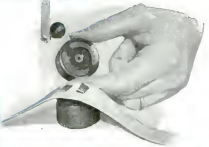
FRUIT JUICE. The reamer shown below rotates as pressure is applied and squeezes out juice without the effort of turning the fruit. It stands on a solid base

ELECTRIC IRONER FOR HOME. A flat-plate ironer is now available for use in the home. It is so mounted that when not in use as an ironer, it becomes a practical kitchen table, the top of which is removed when the iron is in use

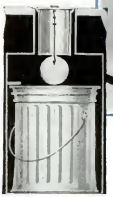
THREE IN ONE. At right, a handy tool to have on the kitchen wall is a bottle opener, a can opener, and a knife sharpener in one

WIRE LIKE TAPE. Below, an outlet plug that may be clipped onto a new type of electric wire in the form of tape, without the use of tools. This tape runs under rugs without making a hump





A DOG BED. Canvas stretched over a metal frame makes a comfortable bed for a dog. The canvas is easily removed for washing



GARBAGE DISAPPEARS. A trap with an aluminum cover, built into the drain board of the kitchen sink, takes care of the refuse problem. When the cover is raised and garbage is dumped into the trap, it drops into receiving can, as shown at left, which is removed from outside the house

POPULAR SCIENCE
MONTHLY

RAYMOND J. BROWN, *Editor*
ARTHUR WAKELING, Home Workshop Editor
ALFRED P. LANE, Technical Editor
SYDNEY OXBERRY, Art Editor

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What's All the Gold For?

THE English pound sterling, once the standard by which the values of all other forms of money were judged, has toppled from its high position. It is no longer worth a fraction over four dollars and eighty-six cents in United States paper money, because the British government can no longer redeem its pound sterling notes with a fraction over four dollars and eighty-six cents worth of gold.

Other countries, following in the wake of Great Britain, have temporarily abandoned the gold standard, and their currencies have depreciated in the same manner.

Lapsing from the gold standard is a calamity, but it is by no means a novelty. It has happened before in England, and there have been times in the history of this country when the gold standard existed in name only.

If every ounce of gold were to be wiped out of existence tomorrow, the industries of the world would not be seriously affected. Gold has many industrial uses, of course, but relatively few where some other metal cannot be substituted with approximately equal results.

Paper Money Ousted Metal

GOLD is valuable not for its intrinsic worth, but because for thousands of years it has been used as a standard of exchange. When people stopped trading one commodity for another and used counters or coins to represent exchange value, gold coins came to be the standard—first, because the metal was so rare that a small coin represented large value, and second, because it is virtually noncorrodible.

However, the weight of gold coins was a serious problem in the days before banks. Travelers had to burden themselves with a weight of gold as well as their traveling equipment, and there was the constant risk of highway robbery. Now paper money has taken the place of gold as a medium of exchange for all ordinary business transactions. Of course a check drawn on a bank is, for practical purposes, just another form of paper money.

The intrinsic value of a dollar bill is, of course, next to nothing. The Government prints them by the million at trifling cost. A dollar bill is valuable only because it represents a promise to pay. It bears the words "One Silver Dollar Payable to the Bearer on Demand," which actually means a dollar in gold, because the Government will redeem a silver dollar with a gold dollar on demand.

Furthermore, you can walk into the United States Mint and obtain for gold bars or gold dust an equivalent weight of gold in the form of gold coins.

So long as this is possible, it is obvious that a paper dollar must be worth a definite weight of gold, and its value as a medium of exchange for other goods cannot fluctuate to any greater extent than that of gold itself.

Trade Balance Calls for Gold

EXPERIENCE has shown that it is not necessary for any government to have on hand as many gold dollars as there are paper dollars outstanding. But when the gold on hand in the treasury falls below a certain percentage of the face value of the paper money in use, the whole system becomes shaky. The situation is precisely the same as that of a bank. No bank ever keeps on hand enough cash to pay off every depositor should all of them ask for their money at the same time.

Gold can be used to form a firm base for a tremendous inverted pyramid of credit in the form of paper money within any given country, but that paper credit isn't worth a row of shoe buttons in international trade. An actual movement of gold must take place to balance the account if one nation buys more goods from another nation than it sells to that same nation. If Willie sells Joe an apple for two cents and Joe sells Willie a top for two cents, the credits balance. But if Willie sells Joe two apples and Joe sells Willie only one top, then Joe will have to fork over two cents in cash to close the transaction.

When financiers put on a wise expression and spout high-sounding phrases such as "unfavorable balance of trade," they refer to the transfer of commodities from one nation to another on a Willie and Joe basis.

Without going into causes, the fact remains that the United States has had the favorable end of the balance of world trade for so long that we now have over half the world's supply of gold stored in our treasury. Obviously, as long as that situation exists the countries so shy of gold that they have slipped away from the gold standard will have great difficulty in getting back to it again. It must be equally obvious that the only way the other countries can get the gold now in our treasury vaults is to sell us more goods than we sell them.

The problem of figuring out a scientific way to accomplish that result without at the same time playing hob with American industries is giving our greatest statesmen and financiers a severe headache.

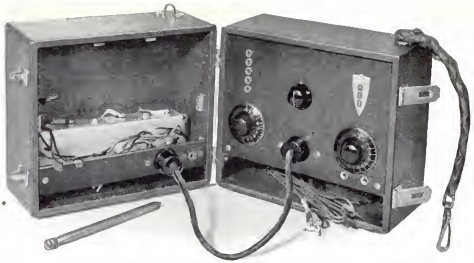


Fig. 1. Portable receiver made by F. C. Turner, Middleburg, Va., won first prize in our set building contest because of fine workmanship and performance

• PRIZE WINNERS *in*

Radio Set Contest

SOME remarkably clever designs for a portable radio receiver of the light headphone type were submitted by readers of POPULAR SCIENCE MONTHLY in the prize contest for radio set builders, announced in our June issue (P. S. M., June '31, p. 79).

In this contest each entrant started with nothing but a semi-picture wiring diagram showing a circuit using a type 232 battery operated screen grid tube in a stage of radio-frequency amplification followed by a detector stage using a type 230 battery operated tube. There were no restrictions as to the make or type of material used in building the portable set. There were no rules as to size, design, or other details except, of course, that the finished set should follow the electrical diagram given.

This left the contestants with the widest possible scope for their own ingenuity and resourcefulness. Five prizes were offered and the sets winning the first three places are shown on these pages. It is evident from a study of these sets that the readers of POPULAR SCIENCE MONTHLY can display both ingenuity and fine workmanship. It would be still more evident if there were space to show the many other excellent receivers entered in this contest.

The beautifully constructed and efficient portable receiver made by Francis C. Turner of Middleburg, Va., was awarded first prize by the officials of the Popular Science Institute. This is shown in Figs. 1 and 2. Mechanically, it is a marvel of fine workmanship. Electrically, it is top notch. The radio receiving unit, in the right-hand section as shown in Fig. 1, is held in place by detents on small levers that engage with notches cut into the metal base plate. Pushing down these levers allows the unit to slide out.

The back view and end views, showing the arrangement of the parts, appear in Figs. 4 and 6, and a picture wiring diagram made directly from the receiver is given in Fig. 5. The front panel measures 5¾ by 8½ inches. The metal base, a sheet of aluminum, is a trifle narrower than the front panel and extends backward 3 5/16 inches.

THE batteries are contained in the left-hand section of the case, the current being carried to the set by means of short four-wire cord fitted to four-prong tube bases at each end, a subpanel type socket being mounted on the front of the panel and another on the connector strip in the battery section of the case.

The compartment just below the receiver unit at the right holds the headphones, the coiled antenna (which plugs into one of the cord tip jacks on the front panel),

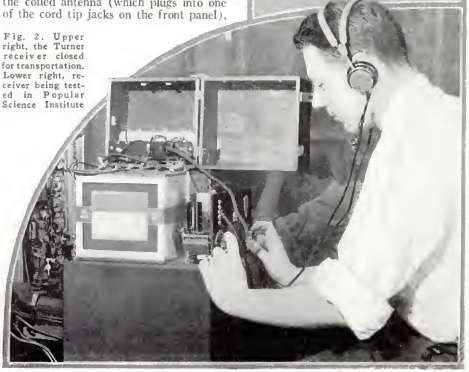


Fig. 2. Upper right, the Turner receiver closed for transportation. Lower right, receiver being tested in Popular Science Institute

Those Who Won

FIRST PRIZE . . . $50
Francis C. Turner,
Middleburg, Va.

SECOND PRIZE . . . $25
Sidney D. Bishop,
Washington, D. C.

THIRD PRIZE . . . $15
Yates M. Hoag, *Utica, N. Y.*

FOURTH PRIZE . . . $5
G. S. Bordner,
New Washington, Ohio

FIFTH PRIZE . . . $5
Charles R. Williams,
Washington, D. C.

ON THE HONOR LIST:

Timothy Aldape, San Antonio, Texas. Eric Blankfield, Ashland, Wis. Theodore Cogley, Spokane, Wash. Donald Ferguson, Gloucester, Mass. Victor R. Fox, Port Arthur, Texas. Paul Idler, Sheboygan, Wis. William L. Johnson, Pomeroy, Iowa. Maurice Landau, Hazleton, Pa. Newman MacNally, Pawtucket, R. I.

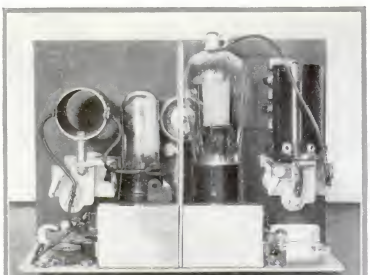


Fig. 4. Above, back view, and below, (Fig. 6), end view of prize-winning set

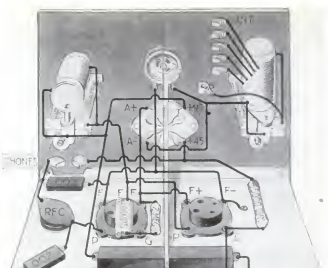


Fig. 5. Picture wiring diagram made directly from the first prize winner

and the connector cord. The brass bolt through the hinges is fitted with a sharp steel point and is used as the ground rod when the set is in use.

THE receiver shown at the left in Fig. 7, built by Sidney D. Bishop of Washington, D. C., won the second prize. This receiver also is a fine job. Electrically it is on a par with the winner. Mechanically, it is strong and sturdy but does not show the perfect workmanship of Mr. Turner's set. The weight of the first and second prize winning sets is almost identical, but Mr. Bishop's set is more bulky and this extra bulk, together with the difference in workmanship, which counts under the heading of appearance, lost him first prize.

The set that won third prize is shown at the right in Fig. 7. It was built by Yates M. Hoag of Utica, N. Y. Mechanically, it rates with the second prize winner. In both size and weight it headed the list, as it is both smaller and lighter than either the first or second prize winners. Unfortunately for Mr. Hoag, however, his receiver is far inferior to both the first two prize winners on the score of electrical efficiency. His coils were not properly placed and inadequate shielding aggravated the condition. To make matters still worse, the A battery circuit was not properly connected, resulting in too low filament voltage for the tubes.

The low electrical efficiency of Mr. Hoag's set more than balanced the lead he had on the basis of size and weight and therefore lost him first place.

The secret of the light weight of the third prize winner lies in a beautifully constructed case made out of balsa wood and carefully covered with imitation leather. Mr. Hoag

is to be congratulated on having designed and built such a remarkably light and strong case for a portable radio receiver.

We feel sure that those who contemplate building a portable receiver for use next summer will find much of interest in a careful study of the three prize-winning sets, particularly as they are so different in design as to present a startling contrast in outstanding features.

The electrical unit of Mr. Turner's set seems almost unbeatable either for design or compactness. That is why we show it so fully in photos and the wiring diagram. Basically the electrical unit of the second prize set made by Mr. Bishop is the same as Mr. Turner's except the parts are larger and more spread out.

MR. BISHOP'S set exhibits two novelties. One is the mounting of the dials so that they can be tuned without opening the case, and the other is the antenna reel which shows quite clearly at the left end of the case in Fig. 7. The crank is detachable and is placed inside the case when the set is being carried.

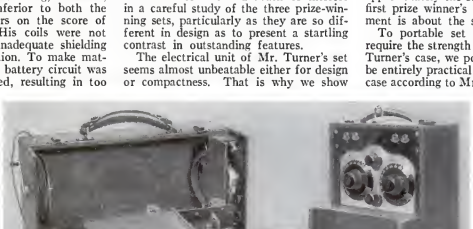
The outstanding features of Mr. Turner's first prize set are the strength and solidity of the construction. The clamlike way in which the outfit closes up, coupled with its strength, makes it capable of standing an enormous amount of abuse.

On the other hand, Mr. Hoag's case design deserves serious consideration from the man who wants the outfit to be as light as possible. Fortunately, the electrical unit in Mr. Hoag's set occupies approximately the same space as does the first prize winner's and the dial arrangement is about the same.

To portable set builders who do not require the strength and durability of Mr. Turner's case, we point out that it would be entirely practical to build a balsa wood case according to Mr. Hoag's design, making it fit a receiving unit built like Mr. Turner's.

The battery and accessory compartments in the third prize of course occupy the space below the receiving unit. There are doors in the back of the case opening to these compartments.

If you want to do a complete job of it, why not see if you can't add Mr. Bishop's neat arrangement for an antenna reel!



Figs. 7 and 8. Left, second prize winner, built by Sidney D. Bishop, Washington, D. C. At right, third prize went to this set, work of Yates M. Hoag, Utica, N. Y.

Making a Good Job of a HOME-BUILT SET

By Alfred P. Lane

WHY is it that one man is forever having trouble with his home-built radio receiver and another fellow, who builds the same set from the same plans, never has a bit of trouble?

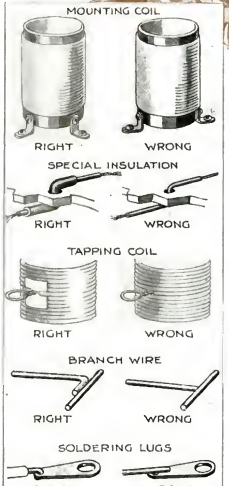
The explanation invariably lies in the workmanship. The two sets may look alike on casual inspection, but a close examination will show many constructional defects in the set that gives trouble. These defects may seem unimportant but they are not, for in nearly every radio circuit the loosening of a single binding post or the failure of a single soldered joint will spoil or even stop reception.

On this page are illustrated just a few of the right and wrong ways of doing some of the jobs encountered in radio work. Take mounting a coil, for example: The position of a tuning coil always is important both as to actual location and the angle at which it is held.

A common method of supporting a coil is by means of a brass right angle bracket bolted to the edge of the coil form. Sometimes it is possible to obtain rigid mounting with only one right angle bracket. In such cases, the coil is braced in position by stiff bus-wire leads. If, however, connections to the coil are made by means of a limp hook-up wire now so popular, the coil connections usually contribute nothing to the rigidity of the mounting.

Most radio experimenters do not realize that all radio receivers have to stand a surprising amount of vibration. Every time you walk across the floor, vibrations race back and forth through the parts of the set. Of course, these vibrations are slight, but they do loosen up binding posts that have not been properly tightened with pliers and in time they will cause wires resting against sharp edges to chafe through the insulation. It is a good rule, therefore, to add extra insulation wherever chafing can occur.

A similar trouble often occurs at the taps on a coil. It always is desirable to slip a piece of strong paper underneath the wire at the point where the tap is made so that the kink in the wire cannot, in time, chafe through the insulation of the next turn on the coil.



These illustrations show clearly the right and wrong ways of doing some of the jobs encountered in building your own radio receiver

Another frequent source of trouble is a broken connection at a point where one wire joins another. Never butt the end of the branch wire against the side of the main wire and flow a little solder into the joint. Always bend the joining wire so that at least a quarter of an inch of it parallels the wire to which it is joined. If the wire is of the stranded flexible variety, the joining wire should be wrapped around the other for a few turns instead of being made to parallel it.

Wherever a hole is provided in a soldering lug, the wire end should be passed through and clamped before soldering.

Learning about Radio

MANY radio experimenters earnestly desire to learn more about the subject and yet they pass up one of the best ways of doing this. The best way to learn about radio is to try to do as much as you can yourself. After you have followed other people's blueprints until you have mastered the mechanics of the thing, try to design a set for yourself. Start by figuring out what kind of set you would like to build. Then attempt to lay out the diagram. You will discover that you are not sure how to make the connections.

By referring to other blueprints and by studying elementary radio books, you can find out why each part of a radio circuit is used and just how it functions.

Furthermore, you will soon find that the whys and wherefores group under familiar headings. For example, a radio-frequency amplifying circuit is always about the same no matter from whose design it is taken. The basic operations in the circuit are controlled in certain ways and the slight differences are due to differing tube characteristics.

Of course the first step in acquiring radio knowledge is to learn radio symbols. A circuit diagram made up of radio symbols shows how the circuit works; a picture wiring diagram is difficult to interpret in terms of electrical action.

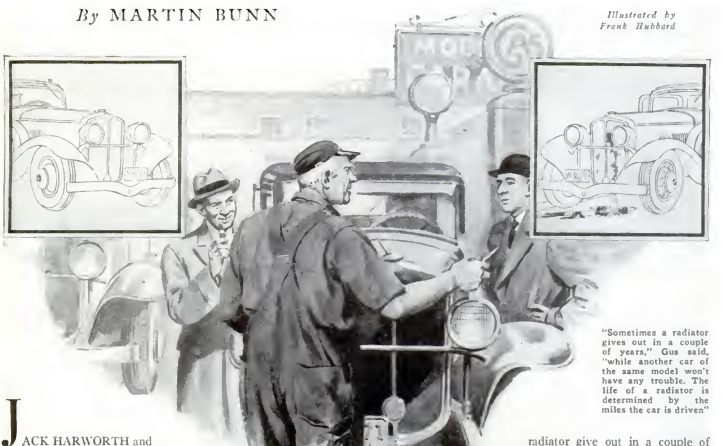
A B C's of Radio...

Everybody knows what happens to an automobile when it encounters a hill. It slows down and gives the same performance, while on the hill, obtainable from a much less powerful car operating on the level. Radio beginners do not seem to realize that radio reception also is full of steep hills and down grades. That is because the hills of radio reception are invisible. You can't see these areas where reception is impeded for some reason, and it is therefore impossible to predict the performance of a set in a given locality.

Doping a Car *for* Cold Weather

By MARTIN BUNN

Illustrated by Frank Hubbard



"Sometimes a radiator gives out in a couple of years," Gus said, "while another car of the same model won't have any trouble. The life of a radiator is determined by the miles the car is driven"

JACK HARWORTH and Danny Malone maintained their close friendship even after Danny landed a job with an upstate firm a hundred miles away. Both men were ardent motorists and there was continual friendly rivalry between the two as to which of them could get the most satisfactory motoring service out of his machine. They invariably purchased the same make of car, perhaps because this put the contest on a more even basis.

"Jack," said Danny, who was in town for a few days, "let's run around to the Model Garage for a few minutes. I must have run over a bad bump without knowing it, because the radiator seems to have sprung a leak. Gus Wilson can fix it."

Jack Harworth grinned as he said: "I ought to teach you how to drive. Then you wouldn't be running over curbstones and things like that."

"G'wan!" Danny growled. "My tires last longer than yours do. That proves I'm a better driver. Hop in and let's get going."

"Go ahead and I'll follow in my car," Jack suggested. "I've been intending to see Gus about the latest anti-freeze dope and I might as well do it now."

"Hello! Damon and Phintias," Gus Wilson called as the two cars pulled up in front of the Model Garage. "Still arguing about how good you are?"

"I'm not," Jack replied. "Danny's licked. His bum driving has busted his radiator. Some motorist, eh, Gus?"

Gus carefully inspected the radiator on Danny's car, tracing back the steady slow trickle of water to the leak.

"Bad driving never did that," he announced as he prodded at the leak with a sharp pointed tool. "See, here's the leak and you'll notice it's a hole through the brass, not an opened-up solder seam. Nope, Danny's driving hadn't anything to do with that. Jars and bumps open seams that are soldered together, but a hole in the brass itself is always due to corrosion. From the looks of this radiator, I'm afraid you'll have a lot more leaks soon."

"What do you suppose caused that?" Danny asked gloomily. "Jack's radiator is still all right. Did I have a defective one to start with?"

"I don't think so," Gus said thoughtfully. "The trouble is you fellows don't realize that plain water corrodes a radiator, and some water is harder on radiators than others. Up where you live, Danny, the water seems to have more different salts and corrosive things in it than ours. I don't mean that the water is bad but as long as water contains impurities, there's bound to be some electrical action, because you have the iron of the cylinder block for one electrode and the brass of the radiator for the other.

"TEMPERATURE has a lot to do with it. Maybe your motor runs a little hotter than Jack's. Heat speeds up chemical action. Remember, too, that the life of an auto radiator is determined by the miles the car is driven and not by its age. That's why you sometimes see a radiator give out in a couple of years on one car while another car of the same model won't have any radiator trouble for five years or so. Check up and you'll find that the first car is on the road all the time and the other one only goes out on Sundays and holidays."

"I suppose," Danny suggested, "that it isn't worth while to solder the leak if the whole radiator is likely to turn into a sieve. Seems a shame to buy a new radiator core when Jack and I expect to get new cars next spring."

"In that case," Gus advised, "you might try one of the liquid preparations they sell to cure leaking radiators. It will stop the leak all right. Of course a careful repair job is the only real way to cure a leak, but the patent stuff may get you by for the winter."

"Dump a can in right now," Danny ordered as he opened the radiator cap. "And while you're about it, fix me up with some of that anti-freeze that doesn't evaporate. Then I won't have to bother about the radiator all winter."

"Nix!" Gus grunted. "If you're not going to have your radiator fixed properly I wouldn't put in any expensive anti-freeze. It may spring a leak any time and you'll spray the road with about four dollars worth of good anti-freeze. You'll have to take your chances with alcohol this winter."

"Won't wood alcohol do?" Danny asked. "It's lots cheaper than the denatured kind."

"Use it if you want to," grunted Gus. "You mean methanol, of course; the violet stuff in the skull-and-cross-bones can. As for me, I *(Continued on page 140)*

THE HOME WORKSHOP

King Arthur's Helmet

SUPPORTS THIS

BOOKRACK

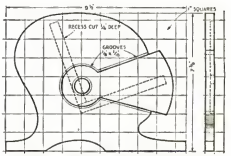
The completed rack and how the end pieces are "hammered" and grooved

WHEN they wanted to be particularly emphatic, knights of old had a habit of swearing to the truth of what they said "by the helmet of King Arthur." You can do something a lot more practical than that and make a King Arthur bookrack—a trough supported by two end pieces supposed to represent the helmet of the legendary leader of the Knights of the Round Table.

The design was submitted by Kenneth Schaffer, of Allentown, Pa., in a contest for story-telling ideas conducted last spring and was awarded one of the prizes (P.S.M., Aug. '31, p. 83). The model illustrated in the accompanying photographs was made from Mr. Schaffer's design by Charles H. Alder. It represents a conventional helmet, undoubtedly much more graceful than the crude ones King Arthur must have used.

Make a paper pattern of the helmet and trace on it two pieces of wood ½ or ¾ in. thick. Cut them out with a jig saw; then use a knife or a wood carver's veining tool to carve a shallow groove around the visor and the small circle in the center. Now grind the large end of a punch or a nail set to a well-rounded shape and use this to give a hammered effect to the outer surface of each helmet-shaped piece. Make the dents close together and space them irregularly, but do not overlap them. Also be careful not to hammer the wood too hard as this will break the fibers and ruin the effect. On the reverse side of each piece rout out grooves ¼ in. deep to receive the ends of the back and bottom pieces, which should be ½ by 4½ in. and ½ by 4¾ in. respectively, and 18½ in. long. Glue these pieces together and then glue on the ends.

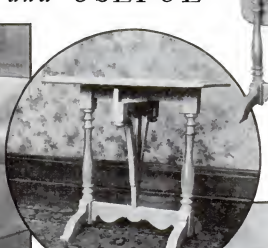
The bookrack can be finished by giving it two coats of aluminum bronze and smearing black shoe polish over the hammered surfaces. Then wipe the polish off with a clean, soft cloth in such a way as to leave some of the black color in the dents. After this has dried thoroughly, polish the helmets briskly with another clean, soft rag.



Outer face and edge view of the left-hand helmet with squares to aid in enlarging it

A New Tilt-Top Table

that's really STURDY and USEFUL



Above: The table with uptilted top as viewed from the rear. *At left:* Top turned down for use

By DONALD A. PRICE

HERE is a rugged, handy little tilt-top table which will find a useful place in any home. While it is not a reproduction of an antique, its turnings and profiles are adapted from authentic woodwork of the "Age of Oak," and it is, therefore, especially appropriate for use with furniture of English or Norman French design. The pivoted support for the top, it will be noticed, is reminiscent of the Gothic architecture of the period. The proper wood to use is oak, which may be finished in a dark antique stain or in silver gray.

The materials needed are as follows:

Legs, 1⅞ by 1⅞ by 22½ in., 2 required.

Feet, 1 1/16 in. thick and shaped as shown by a full size detail on Home Workshop Blueprint No. 140; 4 required.

Bottom stretcher, 13/16 by 3 by 14½ in., 1 required.

Top stretcher, 13/16 by 2 by 14½ in., 1 required.

Pendants, 1½ by 1½ by 5 3/16 in., 2 required.

Swivel top, 13/16 by 2 by 10½ in., 1 required.

Swivel post, 13/16 by 1½ by 14⁹⁄₁₆ in., 1 required.

Swivel struts, 13/16 by 2 by 12 in., 2 required.

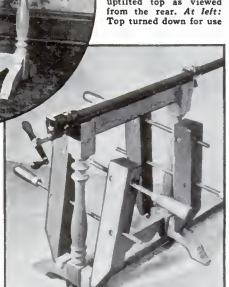
Top, ⅞ by 20 by 24 in., 1 required.

Wedges, ½ by 1⅜ by 3½ in., 2 required.

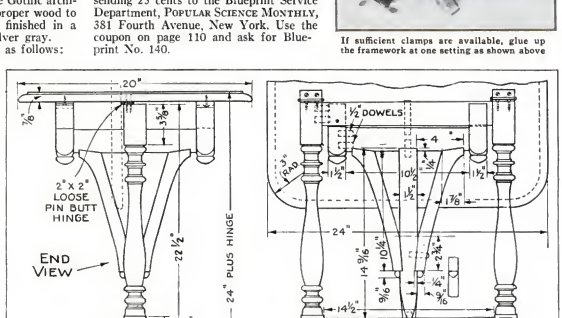
Loose pin butt hinges, 2 by 2 in., brass, 2 required.

All the wooden parts are oak except the wedges, which are maple.

In building a piece of furniture of this type, full size detail drawings are of great help. A blueprint has therefore been prepared with all the more important parts of the table shown full size. It also contains the assembly drawings and several sketches explaining important points of the construction. This can be obtained, together with a long supplementary bulletin giving detailed instructions for building the table, by sending 25 cents to the Blueprint Service Department, POPULAR SCIENCE MONTHLY, 381 Fourth Avenue, New York. Use the coupon on page 110 and ask for Blueprint No. 140.



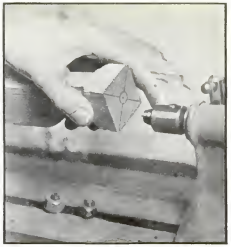
If sufficient clamps are available, glue up the framework at one setting as shown above



Assembly drawings of the table with the principal dimensions indicated and an inch scale for determining those not given. Full size detail drawings of important parts are contained on our Blueprint No. 140

COPIES PRINTED PAGE WITHOUT CAMERA

HERE is an easy way to copy a drawing, diagram, tabulation, or bibliography printed in a magazine or book. Place the sensitized side of a sheet of single-weight photographic paper in contact with the printed page to be copied, making certain that intimate contact is obtained over the whole surface. A sheet of cardboard beneath the page and a glass plate pressed over the photographic paper are aids in assuring a good contact. The exposure is made by having the light from an incandescent lamp shine upon the back of the photographic paper. The light passing through the paper is absorbed where the surface is dark and reflected where it is white, thus making a true negative; that is, the regions dark in the original are light in the copy and vice versa. If there is printing on the reverse side of the page being copied, it will not interfere with the reproduction. With a 60-watt frosted bulb in a desk lamp about 8 in. above the paper, an exposure of about two or three minutes is required. The negative obtained after drying is used to make positive prints in the usual way, the light passing through the negative to the photographic paper. Copies made by this method are facsimiles, and although the method does not give either enlargement or reduction, it obviously has many uses.—EARL J. HAVERSTICK.



GRAPHITE LUBRICATES TAILSTOCK CENTER

SOMETIMES it is advisable not to use oil or grease for lubricating the end of work turned in a lathe, because the oily marks may later cause difficulty in the staining and finishing operations. An excellent substitute—one, in fact, that some workmen use exclusively in place of oil—is powdered graphite. A pinch of this, placed between the wood and tailstock center, will go far towards insuring vibrationless running and decreased heating while turning.—E. W.

IMITATING SMALL WOOD CARVINGS

DUPLICATES of small carvings may be easily made from a wood composition of the plastic type sold in cans or tubes. First tack or glue the original carving, pressed ornament, or model on a smooth board and coat it with thin shellac. When dry, oil it lightly with any thin oil. Next, mix a thick paste of plaster of Paris and water and cover the carving quite heavily, being sure that all spaces are thoroughly filled. The thickness should be at least twice that of the carving. After this plaster is hard, it is carefully removed from the carving.

Brush the inside of this mold lightly with hot paraffin to prevent sticking. Then press composition wood firmly into all parts of the mold and lay it aside for a few hours. When the material is fully set, loosen the edges with the point of a knife and remove it from the mold. Should it stick, heat the mold in the oven for a few seconds; this will soften the paraffin enough to allow the imitation carving to be removed.—ARCHIE AMOS.

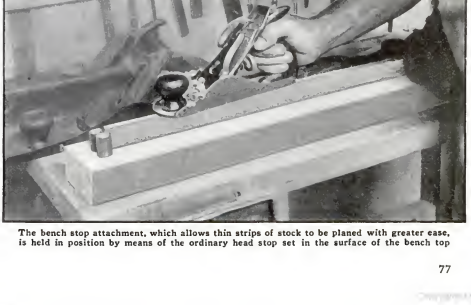
The mold at left, taken from carving shown in center, was used to cast the composition duplicate at the right

RUBBER CEMENT AIDS IN TINTING PHOTOGRAPHS

WHEN tinting photographs, it often becomes necessary to leave some small portion uncolored in the middle of a comparatively large area of tint, such as a white sea gull in a large expanse of blue sky, or windows in the walls of a brick house. In such cases the work may be speeded up and simplified considerably by covering the areas which are to remain white with rubber cement, thinned if necessary with benzol, and applied with a water-color brush. The rubber cement will prevent the tint from coming in contact with the paper and can be easily peeled off when the work is dry. The area which was protected in this way may then be tinted a different color if necessary, as the cement will not have affected the surface.—D. LEECHMAN.

BENCH STOP HOLDS THIN STRIPS FOR PLANING

PLANING the edges of a number of thin strips of wood becomes an easier task if a bench stop attachment is made like that illustrated. Bore holes 1 in. deep in the side of a straight piece of 2 by 3 in. stock to receive two ¾- or 1-in. dowels, leaving about ⅛ in. between them. Drive dowels into the holes and place the "two by three" on the bench up against the regular head stop. Test as shown with one of the thin pieces to be planed. If it is too long and too thin to stand in a vertical position under the pressure of the plane, set other dowels at each side of the piece where they will most effectively hold it straight and reasonably firm. If the "two by three" is straight, the edges of the thin pieces may be jointed accurately.—C. A. K.



The bench stop attachment, which allows thin strips of stock to be planed with greater ease, is held in position by means of the ordinary head stop set in the surface of the bench top

Fig. 1. The home-made clock movement can be seen in view at right

Desk Set with Electric Clock

WINS FIRST PRIZE IN WOODWORKING CONTEST

USING only two small boards, a piece of thin sheet brass, a few inches of piano wire, and some glue and solder, Alan C. Neilson, of Worcester, Mass., constructed a unique desk set which contains among other ingenious features a homemade electric clock. This is but one example of the ingenuity, originality, and craftsmanship displayed by readers who entered our recent woodworking contest (see P.S.M., July '31, p. 89), which called for projects constructed from a specified list of materials.

The remarkable entry submitted by Mr. Neilson, which was awarded the first prize of $50, is shown in Fig. 1. Besides being of pleasing design, this desk set is a revelation in the application of common materials to odd uses. For instance, the novelty timepiece is operated by the alternate expansion and contraction of a length of piano wire. The wire is heated by current from a bell-ringing transformer, whereupon it expands, opens the circuit, contracts, closes the circuit, and repeats the cycle. This movement is transmitted to the clock's one hand by gearing made from bits of wire driven into ebony disks. On each side of the clock are compartments for stamps, paper clips, and similar accessories; and at each end, concealed under a sliding cover, is an inkwell. One inkwell is filled from a large reserve tank set behind the clock, the tank itself serving as a lever-operated diaphragm pump. The other well is filled automatically from a small tank directly behind it. Thin brass was used for inkwells and reservoirs.

The remaining five prizes were awarded as follows: *Second Prize, $25,* to Herbert Wilkinson, of Victoria, B. C., Canada, for the "antique" pitcher, trencher, and bottle shown in Fig. 2; *Third Prize, $15,* to G. N. Humphrey, of Hanford, Calif., for the cigarette container shown in Fig. 3; and *Fourth, Fifth, and Sixth Prizes, $5 each,* to Roy Hancock, of Portsmouth, Va., Emerson Wasser, of Newport, Ky., and Robert Francis, of Pierce, Neb., respectively for the ash tray, rocket boat model, and novel penholder desk set illustrated at right and below in Figs. 4 and 5.

Fig. 2. In making these "antiques," H. Wilkinson, winner of the second prize, did all of the work with ordinary hand tools

Fig. 3. The third prize was awarded for this automatic cigarette box made to resemble a radio

Fig. 4. A nautical ash tray, which won the fourth award

Fig. 5. The rocket boat model *(right)* and pen set *(above)* won fifth and sixth prizes for Emerson Wasser and Robert Francis respectively. Mr. Francis called his entry the "Spirit of '76"

A bootjack model used as a door wedge will add a realistic note to a room furnished in the Colonial style. The bootjack may be given a natural wood finish, or enamel or lacquer may be used to suit an existing color scheme

BOOTJACK MODEL HOLDS DOOR OPEN

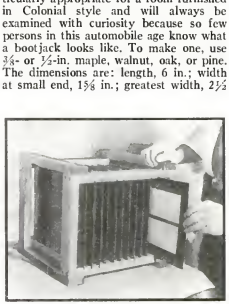
THIS unique door stop or wedge is built like a miniature bootjack, full size models of which were common no longer than a generation or two ago. It is particularly appropriate for a room furnished in Colonial style and will always be examined with curiosity because so few persons in this automobile age know what a bootjack looks like. To make one, use ¾- or ½-in. maple, walnut, oak, or pine. The dimensions are: length, 6 in.; width at small end, 1⅝ in.; greatest width, 2½ in.; V-notch, 1½ in. wide and 2¼ in. deep; strip across bottom, ¾ in. wide and ½ in. thick. Cut the toppiece slightly tapering in thickness toward the narrow end, and make a curved notch in the larger end as shown. Across the bottom nail a strip of wood with the lower surface beveled, and on this surface glue a strip of felt or rubber to prevent scratches and slipping. A natural wood finish is to be preferred, although enamel or lacquer may be used.—ROY ELTON.

NAIL SET ALWAYS HANDY IN HAMMER HANDLE

IF YOU carry a nail set in the handle of your hammer, you will know where it is when you want it. Bore a hole in the handle large enough in diameter and deep enough to accommodate the set without binding. Then, to cover the hole, cut a pear-shaped cap from a piece of sheet metal, preferably phosphor bronze because of its slight springiness. Mount this with a brass escutcheon pin, and make a dent in the center of it, as shown in the photograph below, so that it will remain in place over the hole.—W. B.

Your nail set will always be close at hand if it is carried in the handle of a hammer

A SMALL block plane, with the blade set for a shallow cut, will quickly remove paper from cigar box wood that is to be used for making toys or models.—W. L. F.

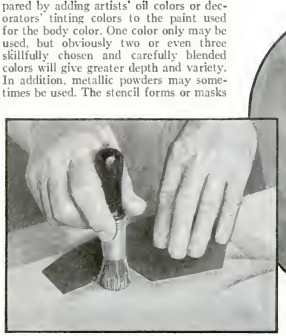


RACK KEEPS FERROTYPE PLATES UNSCRATCHED

THE amateur photographer who squeegees his prints on ferrotype plates to get a glossy finish knows what a nuisance it is to handle these plates without scratching them. The solution is to build a rack as shown. Each plate is held at the four corners so that it cannot touch its neighbor, yet air circulation is not impeded and the prints dry in the minimum time. Wooden strips about ¾ by 1 in. are used for all parts. Four of them are slotted with saw cuts as shown; then another piece is screwed to each end of each pair, thus forming two rectangular frames. These are held in position to form the complete holder by four more strips, two being placed at each end of the frames as shown.—F. D. R., JR.

HOW TO SHADOW-PAINT NOVELTIES

FOLDING screens of modern design and various novelty pieces of furniture, as well as wall panels, can be given a distinctive shadowy finish by the method illustrated. This treatment was recently developed for decorating the walls of rooms in ultramodern apartments. A smooth coat of the body color is first applied. Then the stenciling coat is prepared by adding artists' oil colors or decorators' tinting colors to the paint used for the body color. One color only may be used, but obviously two or even three skillfully chosen and carefully blended colors will give greater depth and variety. In addition, metallic powders may sometimes be used. The stencil forms or masks are cut from stencil paper or medium weight manila board shellacked on both sides. Charge the stencil brush lightly with color and hold it square with the surface as indicated. Pat gently so as to obtain clear, sharp edges at the stencil and a smoothly blended effect where the color joins the body tone.—DAVID WEBSTER.



Left: How the angular stencil forms are used to obtain shadow-painted effects similar to that pictured

Latest and finest of our flying models . . .

The *Winnie Mae* in Miniature

POST AND GATTY'S ROUND-THE-WORLD PLANE

By
J. DANNER BUNCH

WHEN you follow Mr. Bunch's instructions in building this extraordinary miniature plane, you will have the benefit of his numerous experiments and many years' experience. He is one of the greatest designers and builders of model planes. No illustrations, indeed, can do his work justice because they do not reveal the perfection of each joint and detail. He is a skillful aviator and specializes in making stress analyses of large airplanes. Other models of his are shown in our Blueprints Nos. 50, 69, 82, 86, 87, and 89-90 (see page 110)

EVERY airplane model maker must have said to himself, "There's the model I'd like to build," when Wiley Post and Harold Gatty flew the *Winnie Mae* around the world in 8 days, 15 hours, and 51 minutes. I know I had that thought while they were still winging their intrepid course over Siberia; and within a few hours after their plane touched wheels at Roosevelt Field, New York, a telegram came from POPULAR SCIENCE MONTHLY authorizing me to construct the model. The result of the experiments since made is the model illustrated in the photographs on this page and the drawings opposite.

If you construct this model, you will be delighted with its excellent flying qualities. The original model has made hand-launched flights lasting 1½ minutes and extending 2,000 ft.

The ship chosen by Post and Gatty, a Lockheed Vega, is known the world over for its high speed and its great weight-lifting capacity. The designers spent every effort to cut air resistance to the minimum, and the result is a load-carrying airplane with pursuit plane performance. In building the model you will therefore gain an insight into aerodynamics and the most modern methods of airplane construction. The framework of the model is similar to the frame of the full size ship, the main difference being the covering. In the model the main loads are taken by the structural members, whereas in the full size ship additional strength is given by the plywood covering.

There are now numerous model airplane supply houses from which you can purchase at low prices everything required for the model. The essential tools are a pair of small long-nosed pliers, a pair of short-nosed side-cutting pliers, shears, razor blades, and a sharp knife. The writer has also found useful a No. 18 ship or draftsman's curve.

The drawings are practically self-explanatory from the standpoint of an experienced model maker, but they are limited in size because of being restricted to a magazine page. You will find the work a great deal easier, therefore, if you send 75 cents to the Blueprint Service Department of POPULAR SCIENCE

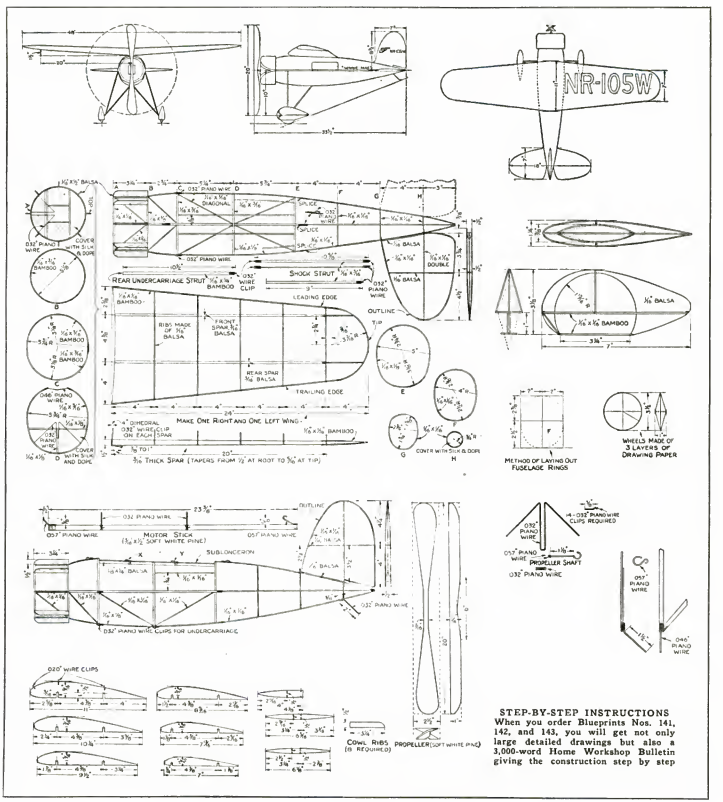
Mr. Bunch holding his 4-ft. model of the *Winnie Mae;* a remarkable snapshot of the model in flight (in the circle); and two photographs of it on the ground

MONTHLY for Blueprints Nos. 141, 142, and 143 (see page 110). These show all the parts and every detail of construction on a much larger scale. With the blueprints you will also receive a Home Workshop bulletin 3,000 words long explaining the construction step by step.

The model, it will be noted, is 33½ in. long and has a wing spread of 48 in. Before beginning work on the fuselage, make a full size layout of the side view and the top view. The fuselage is built of split bamboo in sizes ranging from 1/16 by 1/16 in. to 1/16 by 3/16 in. Rings *A*, *B*, and *H* are circular; rings *C*, *D*, *E*, *F*, and *G*, oval. The fuselage is assembled by cementing and binding the longerons to the rings at their proper locations, the longerons going outside the rings. Observe particularly that there are three bulkheads. Those at stations *A* and *D* form the motor bed and the one at *H* is to stiffen the tail. The undercarriage is built of split bamboo, the wheels are made of three layers of manila drawing paper, and the axles are .046-in. piano wire.

The main wing is built in two halves, one right and one left. The spars are balsa wood 20 in. long, tapered from 3/16 by ½ in. at the root to 3/16 by 5/16 in. at the end. Double bamboo strips 1/16 by 1/16 in. are used for the tips. The propeller is carved from a block of soft white pine 1 by 2½ by 20 in. The covering throughout is Japanese tissue or rice paper applied with banana oil and doped with a solution of four parts acetone to one part banana oil. Detailed instructions for all the operations are contained in the bulletin.

To fly the model at first, use from 30 to 32 strands of 1/32 by ⅛ in. model airplane rubber. When you are more experienced, you can increase the power and launch the model in a tremendous climb. It will continue to float upward and then, after the power has gone, it will glide a long way before touching the ground.

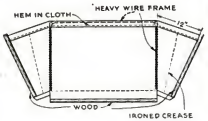


STEP-BY-STEP INSTRUCTIONS

When you order Blueprints Nos. 141, 142, and 143, you will get not only large detailed drawings but also a 3,000-word Home Workshop Bulletin giving the construction step by step

SHIELD KEEPS REFRIGERATOR COLDER

Canvas shield for checking escape of cold air from bottom of refrigerator



All refrigerators, electric and otherwise, possess one bad fault; as soon as the door is opened, the cold air at the bottom flows out in large quantities. Furthermore, in the case of certain electric refrigerators with the mechanism at the bottom, hot air from the condensing coils rises into the refrigerator. The simple attachment illustrated prevents this and effects a substantial saving in the running expense. White duck was cut to the shape shown in the drawing, and a heavy wire frame for the front was made. The duck was sewed to the frame by hand. The two wood strips at the side were fastened to the one at the bottom with brass angle pieces. The side strips were fastened to the shelf pegs. As the front-view photograph shows, there is plenty of room for getting things in or out of the refrigerator. Usually it is sufficient to pull out only one side of the flap. The ironed creases prevent any interference with the closing of the refrigerator door.—Jack C. Cotton.

At left: Pattern for the shield *Above:* How it is opened out to give access to the bottom shelf

HOW TO TIE THE USEFUL PIPE HITCH

The pipe hitch, either in its single or double form, is useful wherever a pulling action between a rope and a pipe or a rod is desired. For pulling pipe out of a well, extracting fence posts and stakes, suspending objects from a rope tied to a vertical post, tying a cord to a toy archery bow, and for numerous other purposes, you will find it worth while to know how to make this knot. The single hitch is employed where a single strand of rope or cable will serve. Its formation is shown in one of the photographs. The double hitch, preferable where a heavy pull is exerted, makes use of a doubled rope. It is, if anything, easier to tie than the single form, provided the rope is not of great length.—W. E.

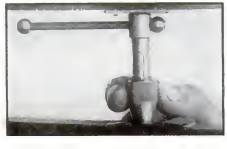
The upper photograph shows how the single form of the pipe hitch is tied. The double hitch illustrated in the oval is stronger and even easier to tie, provided the rope is short

DUSTPROOF CASE HOLDS SHARPENING OUTFIT

Many home workers have wondered why their oilstones have lost some of their original sharpening qualities. This may be due to using a gummy oil, to the continual settling of dust on the oily stone, if it is not kept covered, or to both causes. The sharpening kit illustrated is specially designed to keep the oilstone protected from the dust and also provides a place for the smaller sharpening slips, the strop, and the oil can. Make the base of ¾ by 10 by 18 in. pine or similar wood, with two cleats screwed on its underside as shown. Mount the whetstone in a block of wood, if it was not originally purchased in a wooden box, and fasten it to the base. Make a rack to receive your assortment of slip stones by bradding pieces of wood to the base, and set a short-nozzled oil can into the base as shown. Glue a leather strop at least 2 by 8 in. to the base at the right of the oilstone. Make the cover the same overall size as the base and about 2½ in. high inside to allow for the oil can. The sides may be ½ in. thick and the ends ¾ in., while the top may be cut from thin plywood, ¼-in. pine, pressed wood, or wall board. Hang the completed cover by placing two 1½-in. hinges at the back. Two coats of varnish will prevent oil from soaking into the wood.—K. A. C.

TAP WRENCH FINDS USE IN LAYING OUT WORK

When small parts are being laid out or assembled, a light spreader of some kind is often needed, particularly if the work is such that an ordinary clamp cannot be used. In such cases a tap wrench or small hand chuck frequently will serve as shown below. The jaw nut has a movement of from ½ to ¾ in. and small blocks can be used at either end of the chuck if the distance is too great for it. Even if many small clamps are available this kink is likely to be useful.—F. B.



...Operating a Television Set

In this article, the sixth in a series telling of an amateur's experiences in television, Don Marshall shows how to detect and overcome simple image difficulties

By
GEORGE H. WALTZ, JR.

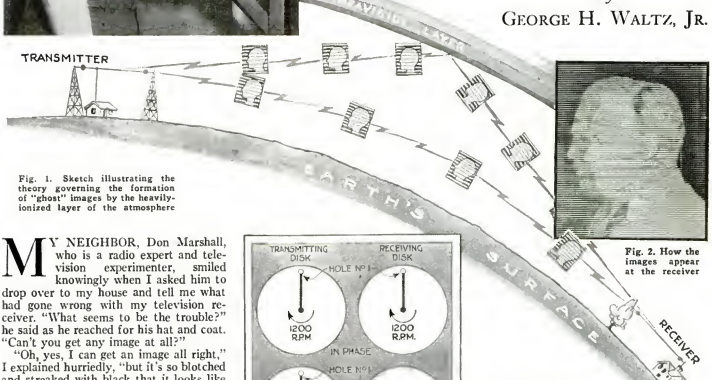


Fig. 1. Sketch illustrating the theory governing the formation of "ghost" images by the heavily-ionized layer of the atmosphere

Fig. 2. How the images appear at the receiver

MY NEIGHBOR, Don Marshall, who is a radio expert and television experimenter, smiled knowingly when I asked him to drop over to my house and tell me what had gone wrong with my television receiver. "What seems to be the trouble?" he said as he reached for his hat and coat. "Can't you get any image at all?"

"Oh, yes, I can get an image all right," I explained hurriedly, "but it's so blotched and streaked with black that it looks like my last year's overcoat does now that it has served as summer rations for the moths. You see," I continued, "the day after you and I finished assembling the parts, I was called out of town on business. Tonight was the first real chance I've had to try out the set. If you remember, when we finished last time it was so late we only had time to pick up a printed signature sign. Tonight I thought I'd try to pull in some of these half-tone programs people talk about."

"Well," Don said as he inspected the disk, "if we hadn't tested the scanner and found it O. K., I'd say the trouble was caused by not having the holes accurately placed. Did you clean the holes after painting the disk black?"

"I certainly did. Then I ran a drill through each hole and took great pains to see that no paint remained around the holes."

"Then I guess dirt must have got in them in some way when we reversed the disk. Try cleaning them out again," Don suggested. "The slightest amount of dirt will cause trouble." (See Fig. 4.)

Fig. 3. A schematic comparison showing in-phase and out-of-phase rotation of the disk

When the holes had again been cleaned, Don's face lighted up as he synchronized the disk and obtained an image free of any streaks or blotches. "That's just one of the things that can go wrong with a television set," he remarked as he shut off the motor and leaned against one corner of the bench. "Sometime sooner or later you'll receive a 'ghost image' and then you'll think you're either seeing double or that the set's got completely out of order."

"A 'ghost image'?" I asked somewhat puzzled. "What is that?"

"You see," Don explained as he made a hasty sketch (see Fig. 1) on a piece of scrap paper that was lying on the bench, "the theory is that as the television signals leave the antenna at the transmitter they resolve into two identical components —one which travels parallel to the earth's surface and another which travels upward. This second component continues upward until it strikes the heavily-ionized portion of the atmosphere called the 'Heaviside layer', which serves to deflect the waves downward."

"Now let me get this straight," I

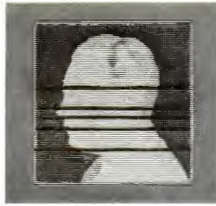


Fig. 4. Dark streaks in the image are generally formed by dirt in the holes

Fig. 5. Images out of frame horizontally are caused by the disk's being out of step

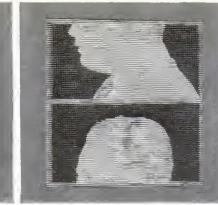


Fig. 6. Image vertically out of frame because of out-of-phase rotation of disk

interrupted. "First, the television signal splits up into two parts and one of these parts travels along the earth's surface and the other travels upward until it hits the Heaviside layer; then it is reflected downward again."

"That's right," Don agreed. "Now, suppose you are in the direct path of this reflected Heaviside component and also receive the earth-bound signal. Each signal will serve to form an image, but since the Heaviside component travels a greater distance it will reach the receiver slightly later than the main component and will form an image to one side of the first image. [See Fig. 2.]

"If this second image," Don continued, "exists only when receiving the signals from certain stations, it is formed by this Heaviside component, and the only remedy is to change the position of the antenna. However, if this second image exists with all stations, it is probably due to the design of the impedences used in the receiver itself."

"While I was on my trip," I said when Don finished his explanation, "I had plenty of spare time on the trains so I did quite a bit of reading on television. Several times I ran across the statement that images out of frame, up and down or vertically, are caused by the fact that the receiving and transmitting disks are out of phase. What's meant by that?"

"The solution to all framing difficulties," Don explained as he made several sketches to illustrate his point (see Fig. 3), "can be found in the theory governing the operation of the scanning disk. To receive a perfect image, corresponding holes on both disks must be scanning relatively corresponding areas on the picture area being transmitted and the plate of the neon lamp. When an image is out of frame vertically," Don continued (see Fig. 6), "the disks are revolving out of phase, which means that when hole number one at the transmitter is passing a spot at the upper left-hand corner, some hole in the middle of the receiving spiral is scanning the cathode plate."

"In other words," I suggested, "the angular positions of corresponding holes on both spirals do not match."

"That's right," Don nodded. "Now you can also receive an image that is out of frame sideways or horizontally. This condition is caused by the fact that while the disks are revolving practically in phase, they are slightly out of step, and that causes the receiving disk to build up the image to one side of the actual position." (See Fig. 5.)

"Sounds rather involved to me," I interrupted. "How do you remedy these troubles?"

"Horizontal framing can be accomplished by shifting the neon lamp to one side or the other until a complete image is obtained. By shifting the lamp you change the position of the image area and cause the disks to revolve in step. Vertical framing can be effected by slowing down the motor with an increase of thumb pressure and resynchronizing. If the picture is not framed by the first try, resynchronize again. If you are using a synchronous motor, it is necessary only to open the circuit momentarily, closing it when the picture frames at the bottom."

Next month Mr. Waltz will continue this series of articles with a discussion of methods of synchronization.

OLD WELL MODEL WHITTLED FROM WOOD

THE old-time well with its iron-bound bucket and golden brown gourd dipper will, before long, be as scarce as flintlock muskets. Before we forget what one looks like, let's make a small well to serve as an ornamental novelty for holding cigarettes and matches, a tobacco pouch, pencils, collar buttons and cuff links, or any small objects.

The model illustrated was made entirely of white pine with one tool—a thin-bladed pocketknife kept extremely sharp. The "stones" were whittled and assembled around a bottle used as a form.

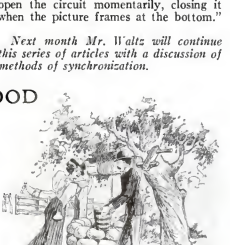
As the well is approximately 4½ in. in diameter, the base should be at least 7½ in. wide. Make it irregular in shape, tapering off towards the edges. Mark the divisions between the cobblestones with pencil or knife blade and cut away the wood as shown.

The well "stones" are cut from blocks of wood 1 by 1 in. in cross section and ranging in length from ½ to 1½ in. A small portion of the tops and bottoms of the "stones" in the first and second layers are left flat so that one layer can be glued to another. The stones for the top layer are left flat on their bottoms, but the other surfaces are cut irregularly.

The well posts are about ⅞ by ⅞ by 5¾ in., but one is a trifle longer than the other. The top ends of the posts are cut irregularly, and the surfaces are whittled to look as if they were rough hewn and cracked from long exposure to the weather.

The bucket is whittled from one piece, bands, staves, and all. The gourd dipper, too, is cut from wood and hangs on a peg inserted in one of the posts. The method of assembling the windlass is shown in the photograph. The crank fits over a square tenon on the end of the roll, and a wooden peg is inserted through the end of the tenon to keep the crank from slipping off. A round tenon on the end of the handle passes through the other end of the crank and is similarly held by a peg.

A sharp penknife was the only tool used by the writer in constructing this well model



This old well model is reminiscent of the days of "Dobbin" and bicycles built for two

A weatherbeaten effect can be obtained by staining the wood with fumed oak stain and rubbing in a little paste white lead here and there to give a grayish cast. The dipper is painted with orange water color, and the cord, which represents the bucket hoisting rope, is stained dark brown.—CHARLES H. ALDER.

For colds
and irritated
throats

Gargle with the SAFE antiseptic

Make sure that the mouth wash you use kills germs. But make doubly sure that it does not irritate tender tissues with which it comes in contact. Mouth washes so harsh as to require dilution may irritate tissue and thereby make it easier for germs to gain entrance to the body. Such irritation also slows up nature's processes of recovery.

Safety wins acclaim

There can be no question of Listerine's safety and its germicidal power. Both have won the commendation of the medical profession. Its entire reputation as an aid in preventing and remedying colds and associated sore throats is based upon these two properties.

If you compare the product itself and its results with ordinary mouth washes and their results, its superiority is at once apparent.

TASTES PLEASANT

Aid in preventing colds

To keep the mouth healthy, gargle with Listerine twice a day at least. Used thus it is a precaution against colds, other mouth infections and bad breath. When you feel a cold coming on increase the frequency of the gargle to from three to five times a day. That often nips the cold at the outset or checks its severity. Millions realize this.

Half as many colds for garglers

Controlled laboratory tests contribute further proof of Listerine's ability to prevent infection.

Of 102 persons under medical supervision for a period of sixty days, one-third, called "controls" did not gargle Listerine; one-third gargled twice a day; one-third gargled five times a day. Note these amazing results:

Colds less severe

The group that gargled twice a day contracted only half as many colds as those who did not gargle at all. The group that gargled five times a day contracted one-third as many. And in both groups the colds contracted were less severe and of shorter duration than in the group that did not gargle.

These scientifically controlled tests, performed on average people under average conditions, definitely indicate the high value of Listerine in arresting infection.

Keep Listerine handy in home and office. Gargle with it twice a day at least. It keeps not only your mouth but your breath clean. Lambert Pharmacal Company, St. Louis, Mo.

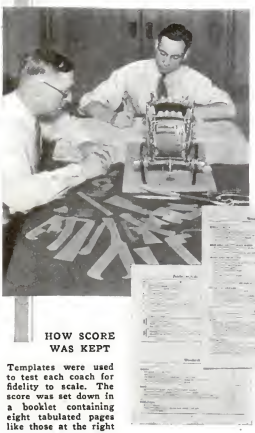
..Reduces Risk of Colds 50%, Tests Show

. . Nation-Wide Miniature Coach Contest Points Way to Better Craftsmanship

BOYS BUILT THESE

Explaining the fine points that make one model better than another. *At left:* This miniature coach won its builder a university scholarship

How to Build a PRIZE WINNING MODEL



HOW SCORE WAS KEPT

Templates were used to test each coach for fidelity to scale. The score was set down in a booklet containing eight tabulated pages like those at the right

EVERY model maker—and for that matter everyone who does any type of fine craft work—can learn several valuable lessons from the inside story of the judging of the first annual coach model competition of the Fisher Body Craftsman's Guild and from hints given by some of the successful contestants. The guild is a national organization of boys from twelve to nineteen years old.

All the models were built from the same plans of a Napoleonic coach provided by the guild. Entries from each State were judged in the State, and the first and second winners—104 models—were sent to Detroit for the selection of the four national winners. From their own experience in conducting home workshop contests, the editors of POPULAR SCIENCE MONTHLY knew what an exceedingly difficult task the judging of the coaches must have been. A representative was therefore sent to Detroit especially to find out how it had been done, and, if any information was available, how the experience of the judges could be turned to the advantage of those readers who make a hobby of building models.

The method used in scoring the coaches proved to be most ingenious and unbelievably accurate. It gave the judges a definite and clear-cut standard by which to test all points of craftsmanship involved. Each coach, it appeared, had been individually scored in a printed booklet containing eight large pages of tabular matter, two sheets of which are reproduced in miniature on this page. The score was divided into six parts, 100 points being allotted to fidelity to scale, 75 to wood craft, 75 to metal craft, 75 to trim craft or upholstery, 75 to paint craft, and 100 points to home-cast and handmade metal parts. If metal castings were purchased, only 50 points could be scored under the last heading; this was so that boys who bought their castings would have no advantage over those who made their own.

In testing a model for fidelity to scale, twenty-four metal templates or gages were used. For example, if the wheel base proved to be perfect—not 1/16 in. off —five points were given the model. If the front wheel diameter with the tire was exactly 3 15/16 in. and the "turn-under" or toe-in was *(Continued on page 120)*

ONE PENNY

# of your building dollar

. . . buys lifelong fuel-saving and comfort for your new home

EVEN if it cost "a lot of money" to insulate your new home with Armstrong's Temlok, it would be worth while because of the money Temlok insulation saves in the cost of heating equipment and of fuel.

But Temlok costs little—in fact, on the average the use of this efficient insulation adds only one penny to each dollar of the first cost of your house.

A warmer house in winter. A cooler house in summer. A smaller investment in heating equipment. Lower fuel bills right from the start. Higher resale value if you ever want to sell. All this gained by adding not more than one per cent to original building costs.

Armstrong's Temlok is the new, improved insulation board perfected after five years of exhaustive laboratory and experimental work by Armstrong. The name Armstrong long has been famous for fine linoleum and an outstanding one in insulation.

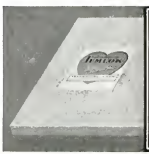
Temlok is permanently efficient. It is made from the heartwood of southern pine, the fibres of which are impregnated with natural resin. This resin makes the fibres highly moisture-resistant. The result is that Temlok has unusually low absorption of moisture and does not lose its insulating efficiency.

Armstrong's Temlok is used as a plaster base, or to replace sheathing, or as wallboard for finishing attics, basements, garages, and farm buildings.

Your local lumber dealer can supply Temlok Insulating Lath or Temlok Insulating Board. The coupon below will bring you a sample and an interesting booklet.

Armstrong's (A) *Product*

Model House at Beacon Hill, Ardsley, N. Y., designed and built by Homeland Company



Armstrong Cork & Insulation Co.
967 Concord Street, Lancaster, Pa.

Please send me free sample of Armstrong's Temlok and booklet, "New Home Comfort at Lower Cost," giving complete details. I am especially interested in:
☐ building a new home ☐ remodeling home
☐ insulating garage ☐ insulating summer cottage
☐ insulating barn ☐ insulating other outbuildings

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Street_____
City_____ State_____

Armstrong's TEMLOK

BUILDING INSULATION

MADE BY THE MAKERS OF ARMSTRONG'S LINOLEUM AND ARMSTRONG'S CORKBOARD INSULATION

Timely Hints for All Who Work on Cars

Fig. 1. Screw eyes and a piece of inner tube can be used to make a good luggage carrier

MANY forms of automobile luggage carriers have been devised for the running board of the car. Figure 1 shows a handy arrangement that is especially suited for the occasional tourist who does not want a more cumbersome arrangement. Heavy screw eyes are fitted to the rear fender and the running board pan by drilling holes through these metal parts and screwing the eye into small blocks of wood underneath. A section of rubber cut from an old inner tube is fitted with strong harness snaps at each end. The rubber strap is doubled over and through the handles of suitcases and snapped into the screw eyes. Of course the position of the screw eyes and the length of the rubber inner tube strap will depend on the nature of the luggage to be carried.

RADIATOR SIPHON

THE obvious method of removing water from the radiator to make room for alcohol or other anti-freeze liquid is to open the petcock and draw it off. A simpler method is to siphon the water out of the radiator from the filler cap opening. Figure 2 shows a way to do this without getting a mouth full of dirty radiator water. A copper or brass pipe is bent into U-shape and a double-ended rubber bulb is fitted to one end. The other end of the rubber bulb is fitted to a piece of rubber tube of any desired length, and a snap shut-off is placed on the tube just below the bulb. To start the siphon, squeeze the bulb flat and release it. Then release the snap and the flow starts at once. When enough water has been drawn out of the radiator, shut the snap valve again.

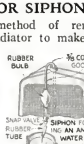

Fig. 2. With a rubber bulb fitted into U-shaped pipe, water from radiator is easily siphoned out

WIN A $10 PRIZE

Each month we award $10 for the best idea sent in for motorists. This month's prize goes to George F. Read, Everett, Mass. (Fig. 5). Contributions are requested from all automobile mechanics and if published will be paid for at regular space rates.

Fig. 3. You can avoid the muddy work of putting on tire chains by using a wire hook

HOOK APPLIES CHAINS

FIGURE 3 shows a clean way to apply chains to tires. Take a heavy wire and bend hooks at each end as shown. Place this around the tire between the spokes and hook into the end links of the chain, which should be stretched out behind the wheel. Now run the car forward slowly and the chain will be pulled around the tire so that snapping the chain ends together is easy.

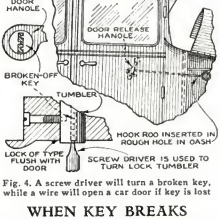

Fig. 4. A screw driver will turn a broken key, while a wire will open a car door if key is lost

WHEN KEY BREAKS

IT IS awkward to have the door key of your car break off in the lock. It is often possible to open the lock under such conditions with the aid of a screw driver. The portion of the key remaining in the lock will hold the pin tumblers in the unlock position, so if you can wedge the end of the screw driver into the key slot it can be turned. A lost key is still more serious, as it usually means breaking the lock, with a repair bill as a result. Figure 4 shows a way to get into the car when the key is lost. Drill a hole through the metal partition at the rear of the engine and hook the inside door handle with a piece of wire.

WINTER STARTING

FIGURE 5 shows a wiring arrangement that will make winter starting easier by automatically providing a fat, hot spark when most needed; that is, while the starter motor is cranking the engine. The equipment required is a stop-light switch and a six-volt, motorcycle-type storage battery. As you will note by the wiring arrangement, when the foot is placed on the starter pedal the current supply to the ignition system is cut off, leaving the motorcycle battery to supply "juice" while the regular battery operates the starter motor. When the foot is removed, the stop-light switch connects the motorcycle battery in parallel with the regular battery so that it is kept charged.

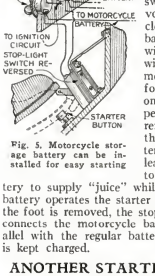

Fig. 5. Motorcycle storage battery can be installed for easy starting

ANOTHER STARTER IDEA

IN OLD cars it is often noted that the self-starter does not seem to have much kick to it even when the battery is freshly charged and the self-starter motor itself is in perfect condition. This trouble is due to corrosion in the joints of the car's frame, which slow down the flow of current between the negative terminal of the battery and the frame of the self-starter motor. A remedy is shown in Fig. 6. Run the ground cable directly to the frame of the self-starter motor instead of to the nearest place on the car frame.

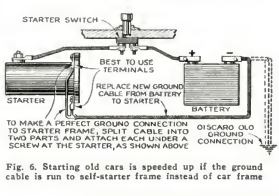

Fig. 6. Starting old cars is speeded up if the ground cable is run to self-starter frame instead of car frame

More than 3,000

SKF BEARINGS On U. S. S. AKRON

The World's Greatest Single Tribute to *Any* Bearing

When the U. S. S. Akron soars aloft, her eight great Maybach motors turn on SKF Bearings . . . her control mechanism operates on SKF Bearings . . . her right angle propeller drives are equipped with SKF Bearings . . . her rudder hinges, elevators, ailerons, mooring spindle, all move upon SKF Bearings.

Throughout this new gigantic marvel of the air are more than three thousand SKF Bearings . . . the greatest single tribute ever paid to the design, the quality, the dependability of *any* bearing.

The same make of bearing was on the Spirit of St. Louis . . . the Columbia . . . the America . . . the Question Mark . . . the Graf Zeppelin . . . the same make of bearing has been on every ship of the air that has written aviation history across the skies . . . and selected solely upon the basis of PERFORMANCE!

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SKF
BALL AND ROLLER BEARINGS

Each of the eight 12-cylinder Maybach motors on the new U. S. S. Akron is equipped with 103 SKF Anti-Friction Bearings. Even the portable mooring mast has SKF Bearings in the spindle that lets the great ship swing with the wind.

2774

Hard-to-Get Photographs

By FREDERICK D. RYDER, JR.

By experimenting with your camera in front of a window, you can learn quickly how to focus close-ups

Panorama taken by turning the camera twenty degrees for each exposure and assembling prints

Contributors to the Home Workshop will find particularly helpful the suggestions on this page for taking close-up photographs. If you submit clear and interesting illustrations with your contributions, you will increase their chance of acceptance. And if they are published, your check will be proportionately larger.

"THE trouble with this picture taking business," remarked an enthusiastic beginner to me the other day, "is that every time I start out to take pictures, I find lots of things I'd like to snap and then I find I can't do it with my camera."

"Why can't you take them?" I asked, smiling at my recollection of the time when I'd bumped into the same trouble.

"Well, to begin with," he grumbled, "how am I going to take a nice close-up picture of a flower when I can't set the camera for a distance less than six feet? How am I going to take a picture of a whole lake when only part of it shows in the finder? How do I take a picture in the woods when I know it's so dark a snap won't give me anything and I haven't any tripod? Isn't there some kind of a universal camera that will take all kinds of pictures with equally good results?"

"I've never found one in a good many years of searching," I replied, "although some of the more elaborate types can do a perfectly astounding variety of work. You'd have to cart around a whole truckload of photographic apparatus if you wanted to be prepared for everything. However, before you do that, why not learn the real possibilities of your own camera? Then if, later on, you get a finer and more elaborate camera, you'll be able to take full advantage of its possibilities."

Most beginners encounter this problem of camera adaptability as soon as they start to take pictures the least bit outside of the beaten track. The trouble is, of course, that most cameras are designed so as to be as simple as possible and still meet the requirements of the average amateur who is interested only in taking snapshots of people, either singly or in groups, and in shooting views that will remind him of the places he has visited. Additional camera adjustments permitting a greater variety of work would only complicate matters for this average amateur photographer and result in more spoiled pictures.

Take as an example the close-up picture of the flower which my friend suggested. The closer you are to an object, the more accurately must the lens be focused. Anyone can estimate six feet within a foot, which is good enough; but few people can guess two feet within a couple of inches. However, you will find that the front of the average camera can be pulled out considerably beyond the six-foot mark, and if you want to take close-ups the job is easy. Some time when the camera is empty, remove the back. Then cut a strip of tissue paper the width of the film and long enough so that you can attach it to the film spools and roll it tight across the picture opening.

Next open the front of the camera and place it on a tripod or on the table pointed at a window. Set the shutter for "T" or "time," and open it. Also move the diaphragm lever so that the opening through the lens is maximum.

Now look at the tissue paper and you will see an image of the window—upside down, of course. By moving the camera nearer or farther from the window and at the same time adjusting the position of the front which carries the lens in its shutter, you can get the shadow image sharply defined. Obviously, you can pull the front out beyond the six-foot mark

Station Y-O-U *and the Face that's Fit*

WHATEVER your station in life may be, your face broadcasts a lot about YOU. If it is well-groomed . . . Fit . . . the world is more likely to give you a hearing.

That is why millions of confident, clear-complexioned men start every day's program with Williams Shaving Service.

Begin with that snow-white Williams lather. Brush it on briskly. It's moist. It's mild. As refreshingly cool as the dawn—but not uncomfortably, chemically cold. A generous lather that conditions the skin as well as the beard.

WILLIAMS SHAVING LIQUID! *Lather in a very new form. Quick. Mild. Just shake a few drops on your brush, and there you are. Great, too, for a shampoo.*

Hold your razor lightly, watch it skim along, leaving a path that's smooth and clean. Notice how relaxed your face feels. No sting. No dryness. No grease to clog the pores—to clog and dull the razor. Williams Shaving Cream is kind—and there is not one atom of dye to mar its purity.

Now thrill to the tingling, tonic touch of sparkling Aqua Velva! Dash it generously over the still-moist skin. It's bracing. It's invigorating. It freshens and firms the tissues . . . helps to care for the tiny, unseen nicks and cuts . . . conserves the good-complexion moisture. Aqua Velva keeps the skin in the pink of condition—clear-toned—all day long.

Williams Shaving Service is for you—for all Face-Fit men who command attention and respect.

JUST NOTICE THE FINE SKINS OF MEN WHO USE

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SHAVING CREAM—AQUA VELVA

MAIL THIS! It will show you the way to Face Fitness

THE J. B. WILLIAMS COMPANY, Dept. PS-140
Glastonbury, Conn., U.S.A.
Canadian Address: 3552 St. Patrick St., Montreal

I am anxious to try Williams Shaving Service. Please send me trial sizes of Williams Shaving Cream and Aqua Velva.

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.....

.....

and then find, by moving the camera, at what distance from the lens to the window curtains the image is sharp. Take a piece of fishline or reasonably nonstretchable cord and put knots in it this distance apart. Also note how much of the window appears in the finder and how the finder view compares with the image on the tissue paper. They will not quite correspond owing to the fact that the finder lens and the camera lens are not in the same line. Scratch a line on the front board to indicate the position of the distance-indicating finger.

When you want to take a close-up, all you have to do is pull the lens out to the marked position, use the knotted string to measure the distance from the lens, adjust the position of the object in the finder, and make the exposure, which should be half again or twice as long as for an object six feet away. If the camera bellows doesn't pull out far enough to get small objects as big as you want, buy a fifty-cent portrait attachment, slip it over the lens, and use the method just described to find the new, closer position which the portrait lens makes possible.

Incidentally, the use of a knotted string to check your distances up to ten feet will result in sharper pictures.

The taking of panoramic pictures with an ordinary camera also is quite easy. Set it up on the tripod (note how often a tripod is needed for serious photography and get one as soon as you can), making sure that it is perfectly level. Turn it around so that the finder takes in the end of the view. Make an exposure and wind in a new film. Turn the camera about twenty degrees and make another exposure, and again wind in a new film. Repeat this process until the last exposure takes in the other end of the view. By careful work in trimming and matching the prints, you can get an excellent panorama view of a whole lake or other wide view. By turning the camera only twenty degrees, there will be a wide margin on each side of each print which is trimmed off in matching, and the result gives less distortion than if you turn the camera so much that the prints match near the extreme edges.

$10

Offered for the Best

Close-up Photo

POPULAR SCIENCE MONTHLY will pay $10 for the most photographically perfect close-up picture of a small object submitted on or before January 1, 1932. The only condition is that it must be taken during the months of November and December, 1931, by an amateur. Any type of camera may be used, and the developing and printing may be done by a professional. Mail both print and negative to the Photographic Editor not later than January 1, and mark your entry "December Photo Contest." If you wish the print and negative returned, send a self-addressed, stamped envelope with entry.

Winner of Third Contest

Carlysle P. Spiesz, of Williamsville, N. Y., has been awarded the $10 prize for the best picture in the photographic contest announced in the third article in the series (P. S. M., Aug. '31, p. 75). Those winning honorable mention are as follows: Scott Boylan, Portsmouth, Va., G. A. Chatterton, Madison, Wis.; Bert Leach, Portsmouth, O.; Noble Matthews, Madisonville, Ky.; Mrs. W. A. Rautio, Ely, Minn.; Harold J. Rose, Pittsburgh, Pa.; James H. Russell, Detroit, Mich.; Erwin Spath, Glen Gardner, N. J.; Stanley R. Stewart, West Point, N. Y.; and J. M. Stofan, Garfield, N. J. The winner of the September contest will be announced next month.

The other problem mentioned by my friend, that of taking pictures when the light is too poor for a snap, is, of course, solved by placing the camera on a tripod or, if you haven't a tripod, by resting the camera against the side of a tree. A very useful accessory in such cases is the optipod, which is a tripod with the legs removed and a universal type of clamp substituted so that you can clamp it to the edge of a table, the top of a chair, a branch of a tree, or almost any other projection.

Another type of picture that often turns out unsatisfactorily for the amateur is the distant view. Suppose, for example, you see some distant mountains enchantingly framed in the opening through a clump of trees a short distance away. The mountains appear clear-cut enough to you, but when you get your prints from the photo finisher or make them yourself, you are likely to find that the distant mountains either have disappeared into the white of the sky or they are so dimly defined as to spoil the effect you wanted.

The mountains aren't to blame, neither is your camera. The trouble is that all very distant objects are somewhat obscured by a blue haze. This blue haze is rich in blue rays to which ordinary film is most sensitive. What you get, therefore, is a fine picture of the haze between you and the mountains. The solution is to use a yellow filter over the lens. The effect of the yellow filter is to cut off the blue rays from the haze and allow the light rays actually reflected by the distant mountains to operate, unhampered, on your film. Yellow filters can be obtained in various densities. On roll film, even the new faster, more orthochromatic types, they greatly increase the necessary exposure. For average distant views, a yellow filter that increases the exposure from three to five times will give excellent results.

If you want to see how much a yellow filter will improve all your distant views, just try taking the same view with and without the filter.

If you have any specific questions to ask regarding picture-taking problems you have encountered, write Mr. Ryder in care of this office, inclosing a stamped and self-addressed envelope for his reply. In the forthcoming January issue, Mr. Ryder will tell how to take pictures by artificial light, and in the February issue he will discuss flashlight photography.

For Rainy Day Shooting—When you get your Daisy be sure to get one of the new Daisy Targets made of fine sheet steel, with patented device to drop shot and keep it from flying. Folds to fit pocket and can be set up anywhere. Great for rainy-day practice in house, cellar or garage.

Rifle Teams— 1932 Style!

Where could a boy find a better partner than his own father, or one better adapted to teach him to be a keen athlete and a good sportsman?

In golf, tennis and shooting you see father and son teaming up together, and every time it's a winning combination.

Many fathers today realize that there's nothing that will promote good fellowship and understanding like target practice. A little stiff competition over the shining barrel of a rifle will do more to help you and your son get better acquainted than anything else.

With a Daisy Pump Gun handy, the "old man" can prove to the youngster that mature judgment and steady self-control count for success both in business life and in sport. And the youngster can give his dad some real stiff competition when it comes to keen sighting and quick trigger action. If you haven't tried it, get in on this fascinating sport without delay.

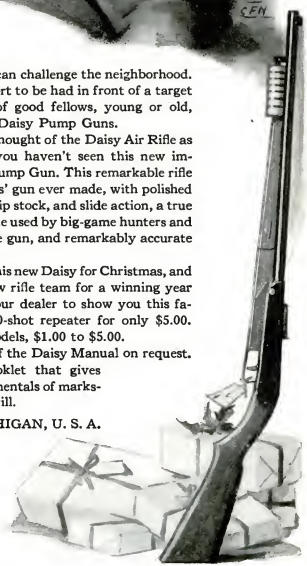
And when you have developed some real skill as a team, you can challenge the neighborhood. There's rare sport to be had in front of a target with a crowd of good fellows, young or old, equipped with Daisy Pump Guns.

If you have thought of the Daisy Air Rifle as merely a toy, you haven't seen this new improved Daisy Pump Gun. This remarkable rifle is the finest boys' gun ever made, with polished walnut pistol-grip stock, and slide action, a true replica of the rifle used by big-game hunters and explorers. A safe gun, and remarkably accurate in its range.

Get the boy this new Daisy for Christmas, and start off the new rifle team for a winning year in 1932. Ask your dealer to show you this famous rifle, a 50-shot repeater for only $5.00. Other Daisy models, $1.00 to $5.00.

A free copy of the Daisy Manual on request. A valuable booklet that gives boys the fundamentals of marksmanship and drill.

DAISY MANUFACTURING COMPANY, PLYMOUTH, MICHIGAN, U. S. A.



DAISY AIR RIFLES

BULL'S EYE STEEL SHOT

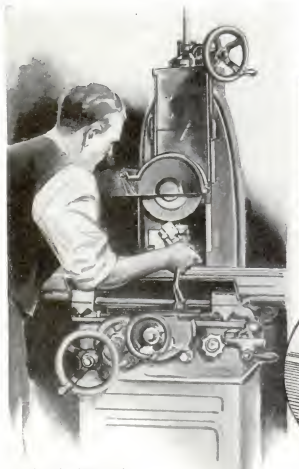
Use Bulls Eye Steel Shot, the cheapest, truest shot for all Air Rifles.

HINTS ON MAINTAINING

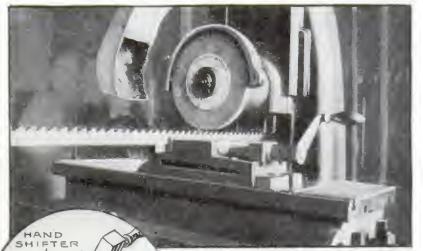
Automatic Chasers *and* Broaches

at Top-Notch Efficiency in the Small Shop

By HECTOR J. CHAMBERLAND



Grinding the lead angle of chasers held in the fixture shown on page 96



Set-up for grinding a broach and, at left, how the traverse feed shifter is locked to make sure the broach will not hit the belt

WHILE it is often possible during dull times for the foreman of a small machine shop to schedule the manufacture of new tools and equipment in an effort to save money, there are certain tools which require special machines and processes and therefore must be purchased. The careful servicing of such tools, which include chasers, broaches, wood planer knives, and lathe tools made of stellite or tungsten carbide, is therefore always an important factor in the economical maintenance of the shop.

Large shops which operate a battery of machines using any of the tools just mentioned usually have special equipment for servicing them, but the small machine shop must provide for their maintenance with the limited equipment on hand.

Chasers, used in connection with die heads, are, from the standpoint of quality of stock, finish, and precision, the finest cutting tools used in the shop.

Every part that goes into the making of the die head is heat treated and ground, so that unlimited service may be expected from it if given due care. The chasers themselves are made of the finest steel and tempered with the utmost care and accuracy. Then they are ground all over and given a lapping operation to insure a perfect thread. Because of all this, they are costly, and therefore it is essential to maintain them in first-class condition. In regrinding chasers, it is most important that the temper, hardness, and shape of the original tool be retained. Even a slight error in judgment during the servicing may be sufficient to reduce greatly the tool's normal life of usefulness. For this reason it is advisable to submit such tools to the inspection department periodically in order that they may be tested for temper and hardness.

It is generally the custom to purchase chasers in sets of four or six, each tool being numbered to indicate its respective location in the die head. Since these tools are matched, the lead angle *X*, the clearance angle *Y*, and the thickness *Z*, as indicated at *A* in the drawings on page 96, must be the same on all tools in the set. If the tools are to be used on steel, the faces should be ground straight; that is, with no rake in either direction.

IF WEAR is apparent on the points, the entire set may be lined up on the magnetic chuck of the surface grinder and sufficient stock removed to sharpen each point. It is useless to risk leaving even a few bad spots in the tools, as they will only tend to shorten the useful life between grinds.

In grinding the faces, no more than .001 in. should be removed at each setting and this should be done by working in from the points to approximately 1/16 in. below the root. The entire face should never be ground at one setting of the wheel.

If chasers are to be used on cast iron, as in the cutting of pipe threads, they should be supplied with a hook rake of from 3 to 5 deg.; and if they are to be used on brass, bronze, or composition metals, they should have a 3-deg. drag rake. To grind these angles, it will be necessary to use some sort of fixture, and the writer, after several years' experience, suggests the fixture shown at *B*. The details and assembly of this fixture, it will be noted, occupy the entire right-hand half of the upper group of drawings on page 96.

THE adjustment plate of the fixture is finished to .500 in. thick so that accurate measurements may be taken as indicated in the diagrams marked *C* and *D*. Fitted to this plate is a square plate, which is also adjustable and aids in grinding the chamfer or lead angle. When once set, the same angle and clearance can be maintained on the entire set of chasers by noting the reading on the handwheel and feeding only .001 in. at a time, working from the edge. Right- or left-hand setups may be obtained by reversing the square plate. When this procedure is followed, the greatest variation which can occur will be .001 in. Since chasers may be obtained in a variety of sizes, the location of the holes for the screws which hold the square plate and chaser clamp are not dimensioned in the drawings.

In sharpening chasers, never remove more stock than is absolutely necessary to sharpen the teeth. Alundum 46 H wheels or a corresponding grade of wheel should be used in grinding.

If by accident a thread becomes stripped

USE STARRETT HACKSAWS

They get paid for ACCURACY: so do you!

Whether you make your living in the air, with the stick of a pursuit plane between your knees . . . or in a shop, at the controls of a lathe or planer . . . it's your *accuracy* that counts.

Starrett Micrometer No. 230. Range: 0 to 1" by thousandths.

It's your accuracy that says whether or not they can do without you. It's your accuracy that sets your rank . . . and the size of your checks.

Whatever you do, it pays...*big*... to be known as the most accurate man in sight.

To give your skill a chance, take a tip from the crack pilots: *make sure your equipment is right*—just as right as human ingenuity can make it. If you work with tools, that means *Starretts.*

There are tools cheaper than Starretts—just as there are planes cheaper than the Army's. But no tools are better than Starretts. No tools make it easier to get the deadly, day-in-and-day-out, split-thousandth accuracy that makes you and your work worth more.

Wright inspector checking the camshaft idler shaft of a Curtiss-Wright Conqueror engine with a Starrett Micrometer No. 2. The dimension is 1.0605 plus or minus .0005.

Determine now to own the Starrett Tools you need. Send the coupon for the latest Starrett Catalog No. 25W. It describes and prices over 2500 Starrett Tools for machinists, auto and airplane mechanics and carpenters; shows how to use them; contains many tables and general data.

For accurate work, in either wood or metal, use Starrett Tools.

Use Starrett Tools

THE L. S. STARRETT CO., ATHOL, MASS.
Please send me my free copy of Starrett Catalog No. 25 W.
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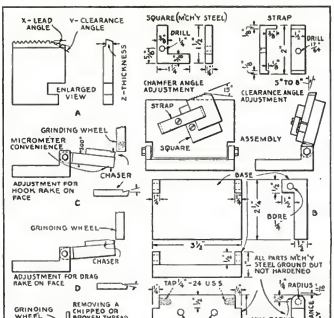
5138

This seal on an advertisement signifies the approval of POPULAR SCIENCE INSTITUTE OF STANDARDS...See page 8

or a corner is chipped off, the entire section must be removed to the root. This can best be done with a small 1/16 to ¼ in. thick elastic wheel, as shown in the diagram marked *E*.

In regrinding broaches, the operator must be extremely careful to maintain an even drop between adjacent teeth, since failure to do so will cause the tool to grab and tear through the metal when it is used. For instance, suppose that it is necessary to service a ¾-in. broach having fifty teeth and a drop of .150 in. for its entire length; by dividing, we find that each tooth should have an individual drop of .003 in.

Broaches, as received from the manufacturer, are ground all over and are properly tempered, therefore the user should never allow such a tool to go unserviced to the point where it will require the removal of more than .005 in. The set-up for broaches is shown on page 94 in a photograph at the beginning of this article. The wheel should be shaped to a 5-deg. angle as indicated in the drawing marked *F*.



Diagrams to illustrate how chasers should be serviced, and assembly and detail views of the grinding fixture

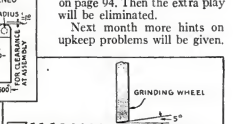
The broach is held in the vise and the cross-feed slide moved forward as far as it will go. The tool is then set so that its lowest or first tooth is approximately at the center of the wheel face. When the wheel has been brought down until it just touches the top of the tooth, it is fed down .001 in. at each setting until the required amount has been removed by noting the graduations on the hand-wheel. The grinding head is raised and the cross-feed slide advanced until the next tooth is in position, when the process is repeated.

When the cross-feed has reached its limit, it is brought forward as far as possible and the broach is relocated in the vise. This process may have to be repeated four or five times. Alundum 46 J wheels or an equivalent grade are recommended for this operation.

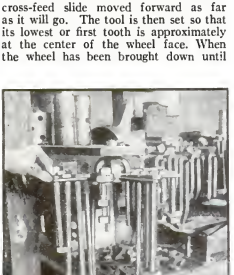
When each tooth on the broach has been reground, the heights should be rechecked with a micrometer.

In order that the broach will not hit the belt as it passes through the grinding head column, the traverse shifting lever should be locked with a parallel clamp as illustrated on page 94. Then the extra play will be eliminated.

Next month more hints on upkeep problems will be given.



Before the teeth of a broach are reground, the wheel must be dressed to a 5-deg. angle

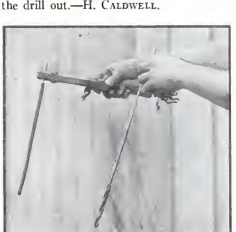


BOLTS FOR MACHINE USE KEPT HANDY IN RACK

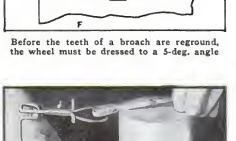
A VARIETY of bolts may be kept ready for instant use at a machine by constructing a revolving bolt rack like that shown above. A spider 4 in. in diameter is bolted to the underside of a board so that it will turn freely, and the board is then attached to a bench, post, or other support as most convenient. Into the edge of the spider are set eight pairs of steel pins ¼ in. in diameter and 8 in. long. These may be spaced to hold whatever size bolt is to be used, and several bolts may be conveniently carried between each pair of pins.—JOSEPH C. COYLE.

REMOVING BROKEN DRILL WITH WELDING ROD

IF AN arc welder is available, twist drills that break off in shafting or other hard metal usually can be removed without difficulty. An electrode about 3/32 in. in diameter is placed in the holder and covered with a piece of rubber tubing beveled to about 45 deg. at the lower end. This tubing prevents the electrode from forming an arc with the sides of the drill hole. The electrode is lowered into the drill hole until it touches the broken drill and then withdrawn for about 1/16 in. The ground, of course, is placed on the work, and the contact must be quickly made and broken. This fuses the electrode to the drill, making it possible to pull the drill out.—H. CALDWELL.



Rubber covered electrode in holder ready to be used, and a broken drill fused to a rod



CALIPER HOLDER SAVES TIME IN FORGING

WHEN forging small flat drills and similar tools, the heat soon runs out. If it is necessary to lay down the hammer and pick up a pair of calipers to gage the work, the chances are that the metal will be too cold before the hammer can be picked up with the result that time must be taken to reheat the stock before the forging operation can be continued. In one shop much of this delay is eliminated by using as an anvil for this kind of work a block of steel placed as close as possible to the gas furnace. To this block is fitted a little device to hold a pair of spring calipers so that the work can be tested quickly without laying the hammer down. On many occasions this saves reheating the work. The holder is made of wire bent as shown in the photograph above, one end being driven into a hole in the block. The calipers are put in place by threading the wire around them, as it were, until the legs can be rested on the looplike support.—W. H. MOORE.

No matter where you buy or where you send Dill's Best in this modern, air-tight, vacuum-pack tin, the tobacco will be fresh when it reaches the smoker.

The more he likes a pipe . . the more likely he is to say

The convenient pocket package of Dill's Best is the first 15-cent tin with moisture-proof Cellophane. In this size, too, Dill's Best reaches you fresh.

J. G. DILL COMPANY, RICHMOND, VA.

SINCE 1848

Dill's Best is America's Best

WINTER STACKS THE CARDS

when you gamble with a makeshift anti-freeze

IT TAKES cold cash to fix a frozen automobile . . . and that's what you may have to use if you risk an anti-freeze that boils away with every sharp rise in temperature. You can't outguess or outgamble winter.

The sure way to safeguard your car through every change of winter-weather is with Eveready Prestone. This is no makeshift mixture, originally intended for some other purpose; it is the first product scientifically developed to keep automobile-engines from freezing—with none of the disadvantages of makeshifts.

Eveready Prestone will not overheat your engine, and it will not boil off. It flows freely in the coldest weather. It has *less* tendency to leak than water. It will not decompose at high engine-temperatures, and gum up your cooling-system. It will not stain or eat away the expensive finish of your automobile. It has no disagreeable odor, and it is non-inflammable.

Last year a million and a half motorists used it for complete, all-winter protection. It is accepted by leading car manufacturers and automotive engineers. Famous explorers depend on it in their polar explorations. This year Eveready Prestone is better even than ever. New substances have been added which form a film of protection over the rough metals of your radiator. These retard rust, and keep the whole cooling-system unclogged and free-flowing.

The first cost of Eveready Prestone is the last. There is no expense of having to test and replenish your mixture every few days. No large repair hill for a frozen engine. Eveready Prestone is concentrated, and only a relatively small amount is needed. Don't go by cost *per gallon;* figure cost *per season,* and see how much you'll save!

Beat cold weather to the punch. Have your cooling-system cleaned today, your connections tightened. Then put in the proper amount of Eveready Prestone. That's all! You've taken the gamble out of winter driving!

NATIONAL CARBON COMPANY, INC.
General Offices: New York, N. Y.
Unit of Union Carbide UCC *and Carbon Corporation*

9 POINTS OF SUPERIORITY

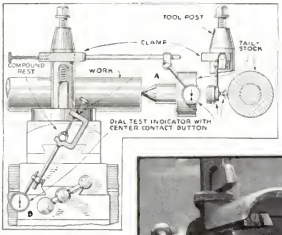
1. Gives complete protection.
2. Does not boil off.
3. Positively will not damage cooling-system.
4. Will not heat-up a motor.
5. Circulates freely at the lowest operating temperatures.
6. Will not affect paint, varnish or lacquer finishes.
7. Non-inflammable and odorless.
8. Prevents formation of rust in cooling-system.
9. Economical—one filling lasts all winter.

EVEREADY PRESTONE

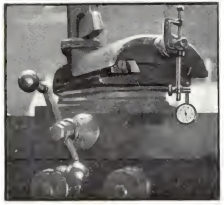
Write for free copy of Eveready Prestone Manual . . . prepared by cooling-system engineers and containing semi-technical information about this remarkable anti-freeze.

NOTE: *When you drain your cooling-system of Eveready Prestone in the spring, put in Eveready* RUSTONE, *for all-summer protection against rust, clogging and overheating. Then your car will always be free of rust.*

MEASURES LATHE CUTS WITH DIAL GAGE



The dial test gage indicator can be arranged in either of the positions illustrated above

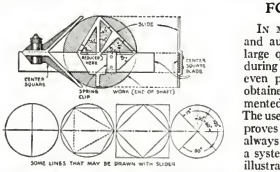


Photograph showing the indicator in place on the cross-feed carriage. The gage used here is the center contact type

OFTENTIMES the dials on the feed screw of an engine lathe become so scratched and worn that the divisions are barely legible, making the setting of the tool for an accurate finishing cut a matter of guesswork. The writer has effectively overcome this difficulty through the use of a dial test gage indicator with center contact point. By placing the test indicator at such positions as *A* and *B* in the accompanying drawing, through the use of clamps, it is possible to cut to accurate depths without referring to the feed screw dials. Cuts may be taken to a depth equal to the capacity of the indicator without resetting the gage.—JOHN E. SERAFIN.

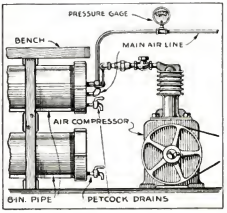
"SLIDER" AIDS IN USING YOUR CENTER SQUARE

WHEN a center square is used with the "slider" illustrated, it becomes a simple matter quickly to square a circle, the end of a shaft, or a bushing, and to draw center lines, inscribed hexagons, triangles, squares, or angles. The slider, which is cut to the angles shown in the drawing, is provided with a spring clip which fits over the beam of the square, allowing it to be slipped quickly from one position to another. The thickness of the slider is reduced at the center as indicated. The writer, who is a machinist in Melbourne, Australia, has found the slider to be a decided aid in laying out key seats in shafting.—H. B. LOWE.



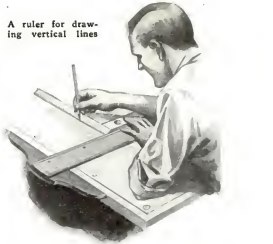
The spring clip on the "slider" allows it to be quickly moved from one position to another

WHEN water or air pressure is not available, the pressure in the oxygen tank of the welding kit can be used to test tanks and pipes for leaks. A hose from the oxygen tank is connected to the work by means of a large tire valve, which has been cut off close to the flange and fitted to the work by means of a ¼-in. pipe thread. The tank or pipe can first be filled with water and the final pressure obtained from the gas tank by setting the regulator to deliver the exact test pressure desired.—A. J. KARLSON.



BIG PIPES ACT AS TANK FOR COMPRESSED AIR

IN MACHINE shops, as well as garages and automobile repair stations, where a large quantity of compressed air is used during the course of a day's work, a more even pressure and constant flow can be obtained if the air compressor is supplemented with some sort of air storage tank. The use of an ordinary cylindrical tank often proves to be a waste of valuable and not always available wall and floor space, but a system such as that shown in the above illustration, which makes use of 8-in. pipe, can be placed against the wall under a bench or group of shelves. In really cramped quarters, the pipe can be arranged vertically. The air line from the compressor and the main outlet line are connected to the pipe considerably above the lowest part. A pet cock should be installed at the lowest part to allow the accumulation of dirt and foreign matter to be blown off. Air tanks thus installed should be tested at about two or three times their normal pressure to insure safety. This may be done safely by filling them with water and then applying the pressure. The water may be removed by opening the pet cocks.—N. V. DAVIDSON.



A ruler for drawing vertical lines

VERTICAL RULER SAVES DRAFTSMAN'S TIME

Measuring and ruling become a single operation with this device

THIS sliding vertical ruler, which somewhat resembles a try-square, is a timesaver for the man who must do much drafting with the conventional T-square and triangles. Instead of ruling vertical lines with a triangle and measuring off the required length afterwards, he can rule the lines with this tool and measure the proper length in the same operation, almost as if using the ordinary type of drafting machine.—W. REICHARD.

Old Bill *Says* . .

A VERY tight belt will soon render a loose pulley useless.

When accuracy is required, never turn a bronze bushing on a mandrel having a taper of more than .002 in. in 6 in.

If shaped and drilled to receive the tang, slices of discarded heavy leather belting form excellent handles for small files.

Fine tungsten carbide tools can be lapped after grinding with a mixture of silicon carbide and diamond powder in kerosene.

Worn solid reamers often can be restored to their original dimensions by a careful application of chromium plating.

This Easily Built FIREPLACE *needs* No Chimney

It burns gas or electricity and can be moved about from room to room like a piece of furniture

By EVERETT EAMES

COMFORT and beauty—the two elements that play a leading part in the modern home—are combined in a well-designed fireplace. Unfortunately, a wood burning fireplace, which requires a special chimney, is an expensive luxury, and it also creates a certain fire hazard and makes extra housework. The modern substitute for it is a gas or electric fireplace which retains all the romance and charm of the open hearth without the bother of ashes or the danger of sparks. Furthermore, such a fireplace is portable and may be set up in any room, or moved from one house to another. A complete fireplace of this type, including real brickwork if desired, may be constructed at low cost in the home workshop.

All that is required is approximately 30 board feet of 13/16 in. thick pine or basswood lumber dressed on both sides, and a small quantity of molding. The bricks may be either thin bricks of the type made by various brick manufacturers as samples for their agents and distributors, or they may be cut from wallboard and then painted with dull colors to imitate bricks, or embossed linoleum of a suitable brick or tile design may be used.

First make a U-shaped frame as shown at *A*, Fig. 1, using plenty of glue and screws. The 12 in. wide top section may be glued up from narrow boards. For building up the design on this base, a selection of stock molding should be obtained from a woodworking mill or carpenter's shop. Several suggestions for standard Colonial moldings are given at *B*, and they may be used as indicated by the numbers on the assembly drawings.

If the fluted pilasters are not available, a design similar to that shown at *D* may be made with molding and a strip of ¼-in. stock 4 in. wide. For this work a good miter box is a necessity.

The plain central motif at the top consists of a ⅜ in. thick board which is glued and nailed in place and framed with a narrow molding. This and the pilasters are attached first; then the molding is run over them as indicated in Figs. 1 and 3. The outside end pieces of the fireplace are

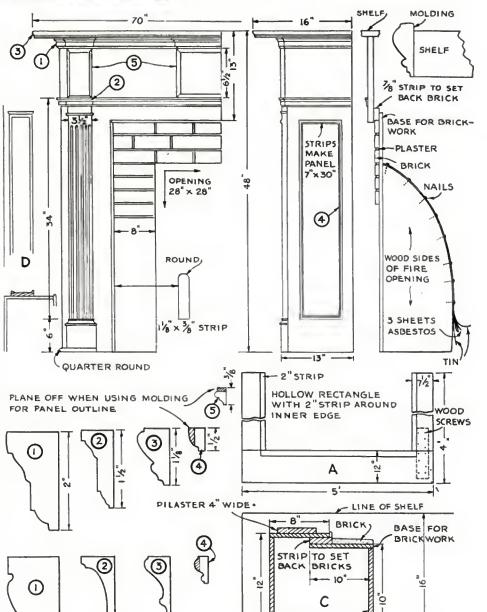


Fig. 1. Assembly drawings of the portable fireplace and details showing points in the construction. Four alternate designs, having hearths, are shown in the sketches on page 100

Hello boys!

Millions of boys know Mr. A. C. Gilbert, champion athlete and champion maker of things boys like. He has devoted his life to the work of making Erector—the most exciting sport any boy ever had.

1000 Toys in One—

Build 'em yourself

1931's Toy Sensation

4-foot reproduction of the New York Central's crack flyer, the locomotive of the 20th Century Limited. Built entirely with Erector. And you can build hundreds of other models as thrilling.

NOT AN ELECTRIC TRAIN

with ERECTOR the World's Champion Toy

Be a real engineer

Step up boys, and see a railroad locomotive built, right before your eyes. Watch a big steam shovel constructed, part by part.

Not by great engineers, but by boys just like you. Why, *you yourself can reproduce the greatest feats of the world's famous engineers!* You don't know how smart you are, you haven't even dreamed of the exciting thrills a boy can have, until you open up a set of my new Erector.

Be the wonder of your neighborhood

Your friends will flock to your home to see you build things with Erector. Excitement! Boy, Erector brings you thrills you never thought possible and fun you'll never forget, no matter how long you live. Once you get your Erector, you'll be sitting on top of the world.

My crowning achievement

Boys, I've worked many years making Erector better and more exciting every year. Last year boys by the million called Erector the world's greatest toy. But the 1931 Erector is *far more than a toy!* It dwarfs all my previous efforts. It is the pathway to engineering fame for clever red-blooded boys the world over. It is the most exciting sport any boy ever dreamed of.

They hum with action

Yes sir! With Erector you can build real models of great locomotives, traveling cranes, ferris wheels, airplanes, and *hundreds* of other modern inventions.

But that's not all. When you've built them with your own hands, hook them up to the powerful Erector electric motor, and they go into action just like the big ones that engineers build. Erector brings you more real sport and fun than a whole year of 4th of July's.

What you get with Erector

Lift the lid of the red brass-bound chest in which Erector comes to you. See the hundreds of Erector parts. Steel girders with interlocking edges, both straight and curved, made of real structural steel. Wheels, gears, boiler, steam shovel, pulleys, cams, axles, and many other parts for building hundreds of models. But that is not all, No sir! You also get the powerful Erector electric motor and many other feature parts, for automobiles, aircrafts, and other models. All Erector parts are interchangeable. Every part necessary to build Erector models comes with Erector.

With Erector comes the big Erector "How to make 'em Book" which pictures and describes every step in the building of each and every model. Any boy who can read can be a boy engineer with Erector.

How to get Erector

There is something about Erector that will fascinate your Dad. Send for the Erector catalog (see coupon). Show it to your dad. Take him to the nearest toy store. Let him see the sport and scientific thrills that only Erector can give. Christmas will soon be here. Tell your Dad Erector is what you want. He'll be pleased, and he'll probably sit on the floor with you Christmas morning and help you build your first Erector model.

95 cents and up

Even though I've improved Erector this year, I've also reduced Erector prices so that more boys can share the thrills of building engineering models. Of course, the bigger the set, the higher the price. But there is an Erector set for almost any price your Dad wants to pay. I wish you a merry Christmas and hundreds of happy days next year with Erector.

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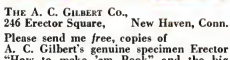

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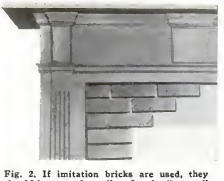
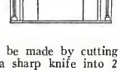


Fig. 2. If imitation bricks are used, they should be spaced to allow for the "mortar"

13/16-in. boards with a paneled effect given by applying moldings as shown in the end view, Fig. 1.

The base for the false brick front should be held strongly in place with heavy screws and plenty of glue (see cross section *C*). If sample bricks are to be used, their usual 1-in. thickness requires that a 1-in. strip 2 in. wide be placed around the back of the opening before attaching base. This will set the surface of the brick 1 in. below the surface of the mantel and give a sunken effect as in a real fireplace. If wallboard or linoleum is used, the extra strip is not necessary. Wall board "bricks" can be made by cutting the material with a sharp knife into 2 by 8 in. pieces.

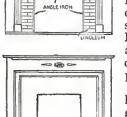


The wooden inside ends of the fireplace opening are next attached as shown at *C*. It is advisable to cover these with two or three sheets of 1/32-in. asbestos (such as used by plumbers for wrapping small steam pipes) and a covering sheet of tin. The back, which is nailed to these two pieces, consists of two sheets of tin (Fig. 1) between which are placed three sheets of asbestos. Better than tin for lining purposes is a scrap piece of steel siding stamped to imitate brickwork.

NOW lay the mantel on its back, and center each brick or imitation brick with brads driven in as tightly as possible against their edges, allowing for ½ in. of mortar between each brick (see Fig. 2). The mortar is ordinary patching plaster; and if sample bricks are used, it must be handled carefully to avoid discoloring the bricks. In the case of wall board "bricks," any overflow can be rubbed off before the paint is applied (dark red roofing paint will give the required dull finish). When the plaster is half set, scrape out the excess with a rounded stick in order to make a neatly "pointed-up" job. The plaster, which will set firmly overnight, may be allowed to remain white, or it may be painted to resemble black or dark gray mortar. The sides and back of the opening should be painted black or some dark color. The mantel itself should have at least three coats of flat enamel undercoater and one coat of enamel to match the woodwork of the room in which it is to be used.

Usually three or four 3-in. finishing nails carefully toenailed through the back edge of the shelf into the plaster and lath will be sufficient to hold the mantel in place. If possible, locate the studs in the wall and drive the nails into them. Strips of quarter-round molding of the same size as that used in the room should be used to secure the lower portion in place and put a finishing touch on the whole job. A 1 by 3 in. strip, beveled on the edges, may be placed at the back of the shelf to give the effect of permanency.

ALTHOUGH not used on the fireplace illustrated, a hearth may be added. The easiest way to make it is to use a board for the foundation and cover it with brick-design linoleum, afterwards trimming the outer edges with a suitable molding. Hearths are indicated in the four designs suggested in the thumb-nail sketches at left, which illustrate the variety of effects possible by combining a few simple elements. Hearths are usually furnished with commercial fireplaces.



Gas fireplace heaters actually give out heat, but electric fireplaces of the inexpensive type are imitations pure and simple, although amazingly realistic. Various types of heaters are available. If no gas outlet is at the best location for the fireplace, a plumber can easily carry a ¼-in. pipe under the flooring in such a way that a flexible rubber tube can be run to the heating unit in the fireplace opening.

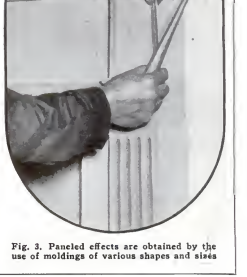


Fig. 3. Paneled effects are obtained by the use of moldings of various shapes and sizes

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How Good are YOU at Counting?

By ARTHUR L. SMITH

● THIS *is a new and original puzzle by a man in the highest ranks of the puzzlers' fraternity. It was suggested by a clever card trick Mr. Smith saw performed when a boy—a trick in which the conjurer counted off cards O N E one, and so on, while placing a card underneath the pack for each letter and throwing the number out when the word was pronounced*

A CIGAR box and two or three butcher's wooden skewers will make this puzzle, which will be found much more interesting than may appear from merely reading the description. The material is about 3/16 in. thick, and the skewers ¼ in. in diameter. The bottom pieces are 2½ by 5 in., as shown in Fig. 1. Only the toppiece is bored to receive the posts, and then the pieces are glued. The hole centers are marked in the bottom piece by driving a brad through from the top and then removing it. The posts are glued in, and a brad is driven through from the bottom to reënforce each of them.

The tall post holds ten blocks, 3/16 in. thick and 1 in. square. The other posts are made to hold only five blocks each. The blocks are lettered and numbered as in Fig. 2. It is convenient to have the numbers on three sides.

The problem is to count off the blocks as O N E *one*, T W O *two*, and so on, transferring a block for each numeral and letter as pronounced, but as the number is pronounced to have the block correspond in number to it. That is, each time a letter is pronounced, as O N E, any block can be moved from one post to any other, but when the complete number *one* is spoken, the only block that can be moved is that which bears the figure *1*. The number, therefore, must always lie underneath the block of the last letter pronounced in the spelling.

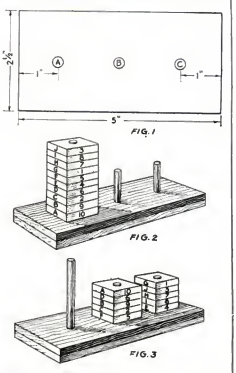
The letters on the blocks have nothing to do with the puzzle except to facilitate the placing of the blocks on the tall post in proper sequence. A different block must be removed for each letter and numeral of one count, after which a block moved before is again subject to removal.

Naming the posts *a b c* as in Fig. 1, one solution is as follows:

O a to b	T a to c	U c to b
N a to b	H b to c	R c to b
E a to b	R b to a	4 c to b
1 a to b	E b to a	F b to c
T a to b	E b to a	I b to c
W a to c	3 b to a	V b to c
O a to c	F c to b	E b to c
2 a to c	O c to b	5 b to c
S c to b	7 a to b	I a to c
I c to b	E c to a	N a to c
X c to b	I c to a	E a to b
6 c to b	G c to a	9 a to b
S b to c	H c to a	T c to b
E b to c	T b to a	E a to c
V b to c	8 b to c	N a to c
E a to c	N b to c	10 a to b
N a to b		

Half of the numbers have now been moved and the remaining moves to complete the puzzle are as follows:

It is not necessary for the blocks to be in the same order as in Fig. 3 when solved. Different moves will cause variations. It is interesting to work out different sequences of the figures from that shown in Fig. 2 to get different solutions.



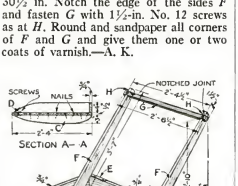
Plan view of board (Fig. 1); how the blocks are arranged at the beginning (Fig. 2); and their positions after one solution (Fig. 3)

SCOOP ON RUNNERS AIDS IN REMOVING SNOW

SNOW may be easily scraped up with this scoop and pushed out of the way. If it can be dumped on to a lower step or terrace, a large area may be quickly cleared.

Cut out two sides of ash or other light but hard wood, ¾ by 4 by 27¼ in., and the back ¾ by 4 by 28½ in. Shape the sides as shown and nail together at the corners. Make the bottom of pine or other light wood, ½ by 28 by 30 in., using three or four pieces, preferably with a piece of hardwood at the front edge, which will receive hard usage. Shape this edge to continue the form of the sides, and fit a piece of 22-gage galvanized iron 5 in. wide and about 36 in. long to protect it, bending the ends over and fastening them to the sides as at *B*. Fasten the edges with ¾-in. tinned trunk nails as at *D*, driven through from both sides and well clinched.

Get out two hardwood runners *C*, ¾ by 3 by 28 in., and shape them about as shown. Fasten them at the front with screws, and nail the bottom strongly to their top edges with fivepenny common nails. Bend two iron straps *E*, ¾ by 16 in., and fasten them with fourpenny nails to strengthen the back corners. Make two ash push bars *F*, ¾ in. thick, 43 in. long, and tapering in width from 3 to 1½ in.; also one ash cross handle *G*, 1 by 1½ by 30½ in. Notch the edge of the sides *F* and fasten *G* with 1½-in. No. 12 screws as at *H*. Round and sandpaper all corners of *F* and *G* and give them one or two coats of varnish.—A. K.



A strong wooden scraper for snow

TO KEEP safety razor blades from rusting between shaves, I place them in a dessicator—an air-tight laboratory dish—with a dessicant such as calcium chloride of the granular porous type. By this method I have been able to use one blade forty-five times.—R. T. TYLER.

Lighted Animals *Brighten the Party Table*

By WALTER E. BURTON

These curiosity-provoking and attractive novelties are made from ordinary ten-cent celluloid toys.

A grotesque elephant and a big goldfish, both made luminous by concealed flashlight batteries and bulbs.

TAKE a dozen hollow celluloid animals and an equal number of flashlight batteries, lamps, and pigtail sockets, mix them properly, and you have something new in the form of unique novelties for the dinner or party table.

This recipe for making unusual table decorations was worked out by L. C. Porter, of Cleveland, an expert in the engineering department of a large electrical manufacturing company. He claims for it the merits of simplicity, low cost, and attractiveness.

You can obtain celluloid elephants, fish, camels, ducks, and almost any other animal at the toy counter of most five-and-ten-cent stores. Select those that have the largest volume, so that there will be room for the lighting equipment which you must introduce.

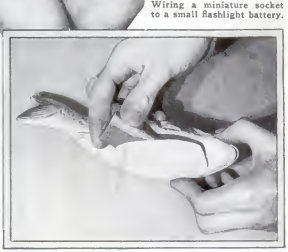
You must have, too, a flashlight battery for each animal. The small, flat, two-cell ones having protruding brass strips at one end are usually preferable because of their shape. These batteries can be obtained in two sizes; the smaller should be used for small sized figures.

A new battery ought to operate a No. 1 mazda lamp for two or three hours at good brilliancy. It is a wise plan to test one of the batteries in the lot to see how long it will retain its vigor. If the lamp burns only ten minutes or so, the batteries are old and should not be used because the light will disappear just when it is becoming most effective.

Besides the batteries and the lamps, you will need lamp sockets of some kind. The most convenient to use are the so-called "pigtail" sockets. These are miniature sockets with two short lengths of wire or pigtails attached. If you cannot obtain such sockets, you can employ radio dial light holders, to be found at most radio parts counters or radio stores.

Another solution is to construct a simple socket from any bare copper wire that is heavy enough to retain its shape. Wind one piece in the form of a coil into which the bulb base will screw, and arrange the other so that it presses against the central contact of the base;

Wiring a miniature socket to a small flashlight battery.



The lamp and battery are inserted through a slot cut in the hollow celluloid toy—in this case a goldfish.

or better still, solder it to the contact. In fact, you can solder short pieces of insulated wire to both terminals of the bulb, and connect the other ends to the battery by twisting them about the brass strips.

Whatever method you use for connecting the lamp to the battery, the next step is to place the lighting system inside the animal. In the bottom or back, slit the celluloid with a knife or razor blade in such a way as to form a little door. Pull the flap or door out, insert the battery and bulb, and arrange the latter so that its light will strike as much of the inside surface as possible. This, of course, must be done just before the dinner starts. These table novelties are effective only in the dark, but they give out a certain amount of light themselves. Half a dozen of them, placed one at each plate, will give sufficient light to see by.

The cost of each illuminated figure will be about 40 cents, counting 10 cents each for the animal, lamp, battery, and socket.

TINY HOTHOUSE GIVES DELICATE CUTTINGS A QUICK START

A starting box inclosed in glass so that the temperature and humidity can be controlled.

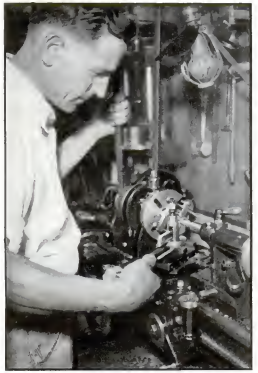
THIS Tom Thumb hothouse is a unique little design, which can be made in fifteen minutes. It encourages delicate cuttings to take root much more quickly.

Select a shallow wooden box 18 by 24 in. (or any dimension desired) and 4 in. deep. Spray inside with a lime solution to keep fungi from growing; then fill the box with suitable soil. Now cut sheets of glass the right size to stand upright close to the inside edges of the box. Press the sheets into the soil and secure the corners with strips of adhesive tape or passe partout binding. Cover with another glass slightly larger than the top.

The advantage of this hothouse is that the cover glass can be moved about, thereby regulating the heat and humidity by the size of the opening in the top. A small thermometer placed in the soil will give the temperature.—M. E. CRUMB.

HOLT CONDON, *expert toolmaker, tells the amateur*

How to Machine a Lathe Dog



In learning to operate an engine lathe, it will pay the beginner to design and make a lathe dog

SINCE a man learns best by actual experience, the amateur mechanic who possesses a small engine lathe can best acquaint himself with machining operations by building his own lathe accessories and tools. The writer, in equipping his home machine shop, has not only saved money but also derived pleasure and personal satisfaction from the work, which is well within the scope of the amateur.

As the writer's idea was to make all the required accessories, he first mounted the chuck as described in a previous article (see P. S. M., Nov. '31, p. 115) and next undertook to machine a driving dog for turning work mounted between centers. As the jobs attempted on a home workshop lathe do not, as a rule, require extreme strength in this accessory, and since a wide range of usefulness seemed to be the main consideration, the design of dog illustrated in the photographs was decided upon. It can accommodate all diameters from ¼ to 3 in. and can handle angular sections equally well.

The jaws of the dog were worked up in the vise from cold-rolled stock ⅝ by 1¼ in. in section, and the shoulder screws were turned from ½-in. stock and then threaded 5/16-in. No. 18 U. S. S. To allow easy adjustment, the shoulders were knurled, and the heads of the screws were squared up to fit the lathe tool-holder wrench. The stud or tail of the dog was turned and shouldered to he a press fit in the longer jaw, which had been drilled and countersunk to receive it. To stiffen the parts and add beauty to utility, the jaws and screws were next casehardened by the cyanide process. The stud, left soft, was then forced in and riveted into the countersunk hole. To cushion the tail and increase its diameter to the width of the faceplate slots, a fiber sleeve was pressed over it. This tail construction was decided upon in an attempt to reduce the eccentric weight.

It would have been better to chase the screw threads in the lathe rather than to cut them with a die, but up to that time the writer had not equipped his lathe with the cross slide stop shown in the photograph. This, however, was soon added, and it is now ready for the next chasing job.

The holder for the knurl was made from machine steel and casehardened. The pin, made from drill rod, was hardened and held in place with a cotter pin. The two knurls, both fine cut but one with a straight and the other with a diamond pattern, were purchased.

JUNK YARD YIELDS AIR COMPRESSOR FOR SHOP

NEARLY every home workshop enthusiast, especially if he is an amateur machinist, has many uses for compressed air, but does not have either the equipment or the experience to build a compressor, and at the same time he hesitates to buy one. By making a trip to an auto junk yard, it is usually possible to pick up a compressor very cheaply, as many trucks and even some of the higher priced pleasure cars have tire pumps connected to the transmission for the purpose of inflating tires. Although called "tire pumps," these are in reality small compressors; and when connected to the shop power plant and some suitable tank, they form a dependable source of air.—ALLEN ZERBE.

HOW TO BUY CHEMICALS TO BE USED IN YOUR HOME WORKSHOP

SHORT articles on home workshop chemistry have been published in POPULAR SCIENCE MONTHLY for many years, during which time questions have been asked repeatedly in regard to purchasing the chemicals mentioned. As a rule the question is accompanied by the comment that an effort was made to obtain the chemicals locally and they were either not in stock or the clerks had never heard of them.

To illustrate how hard it is to know what to ask for, one has only to go into a large paint or hardware store and demand copper sulphate. An inexperienced clerk probably will shake his head and say that the store does not carry it, but tell him that you mean ordinary bluestone and the chances are that he will smile and give it to you. Both names and also the term "blue vitriol" are used to designate the same chemical.

Many of the more common chemicals have at least two names under which they may be sold. This is, of course, confusing. If you ask for muriatic acid and receive hydrochloric acid in its place, you are likely to wonder if there isn't some difference, but both names indicate the same acid. So, in the same way, do not be surprised if, when you ask for water glass, you receive a bottle or can labeled "sodium silicate," or on asking for sodium silicate you receive a container labeled "sodium silicate solution." If you know one designation for a chemical, you can look it up in an unabridged dictionary and quickly learn any others.

ANOTHER important consideration is the price paid per pound. In the paint store you can probably get a pound of copper sulphate for twenty-five cents, whereas in a drug store you would have to pay at least twice as much for the same quantity. There is a good reason for this variation. The copper sulphate called "bluestone" or "blue vitriol" in the paint store is an impure salt often mixed with dust and dirt and contaminated with other chemicals. The chemical sold in a drug store, however, will be absolutely pure.

Ordinarily the cheaper type of salt, designated by the term "technical," will be found to answer the purpose just as well as the pure and more expensive kind. The chemically pure salt is rarely employed in the home workshop. Whenever pure chemicals are required, those known and marked "C. P." (chemically pure) or "U. S. P." (United States Pharmacopoeia) should be used. For this purpose never use those marked "technical" or "tech.," as it is usually abbreviated.

It is wise to buy small quantities of expensive chemicals and larger quantities of cheaper chemicals. It is costly to purchase cheap chemicals in small amounts. Take copper sulphate, a pound of which in the technical grade may cost about a quarter. If you require only an ounce, it may cost you ten or fifteen cents. It will obviously be wiser to buy a full pound, especially as this chemical has many uses and is easily stored.—H. BADE.

This MODERN

Electric Clock Case

Serves as a PIER CABINET

By EDWARD ELLISON

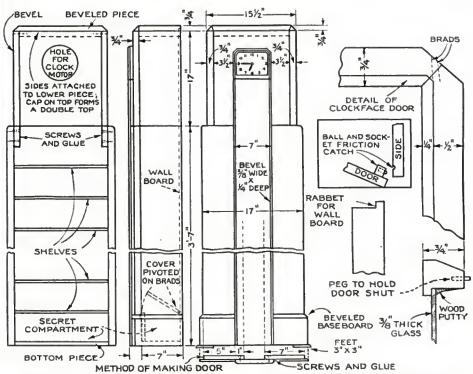
ALTHOUGH little harder to build than an ordinary box, this piece of furniture is an electric grandfather's clock in the most modern style. And it is more than just a clock, for the entire lower section of the case can be used as a pier cabinet for storage purposes.

Twenty-five board feet of ¾ by 7 in. whitewood and 8 ft. of ⅜ in. thick stock for the shelves are required. Build the case as shown in the sketches, but note the odd shape of the cabinet door. It is built of three pieces; and the central member, which forms part of the design of the front, projects above the opening right up to the clock door. The latter is a separately made glass-filled frame; it is like a picture frame except that the top corners are beveled off. The hinges with which it is hung are countersunk so that it will close flush against the front of the case. It is kept shut by the simple expedient of setting a peg permanently into the frame as shown, and drilling a hole in the case into which the peg will fit tightly. The main door is held shut by ball type friction catches at top and bottom.

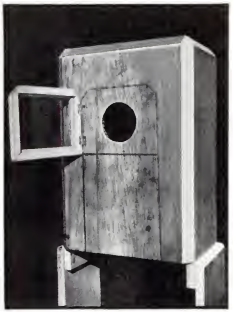
The convenient shelves in the clock case make it especially suited for use beside a desk

The bottom shelf is hinged on two finishing nails driven through the boards that form the side of the case. It can then be turned up to reveal a secret compartment large enough to hold a strong box.

The back is covered with wall board set



Drawings showing the simple construction of this unusual two-use clock. Whitewood ¾ in. thick serves as the stock, and only the simplest of joints are used in assembling the piece



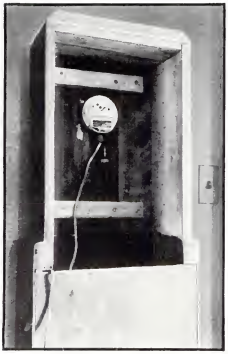
The clock door hinges are recessed to allow the door to close flush against the cabinet

flush in rabbets in the sidepieces and top. A hole is cut directly back of the clock unit for adjusting the hands.

The electric clock unit may be purchased separately or taken from a low-priced kitchen model. The numerals on the cardboard face are laid out on an ellipse divided like any clockface.

Stain and varnish, well-rubbed down with pumice stone and oil, give the preferred finish, but a colored enamel finish also is suitable if the enamel is carefully flowed on over several well-smoothed coats of flat wall paint or enamel undercoater.

Make sure, before buying the electric clock movement, that your lighting company supplies 100-130 volt, 60-cycle alternating current necessary for the operation of electric clocks and that it maintains a time correction service. If such is not the case, a spring wound clock unit may, of course, be substituted.



The clock unit as seen from the rear before the upper part of the back was set in place

BLUEPRINTS

to Help You in Your Home Workshop

TO ASSIST you in your home workshop, POPULAR SCIENCE MONTHLY offers large blueprints containing working drawings of a number of well-tested projects. These prints are the result of a pioneer effort begun by this magazine in 1922 to provide readers with authoritative drawings at a nominal price. This service has grown to be by far the greatest of its kind. It is conducted solely for your benefit, so do not fail to take advantage of it at every opportunity.

The blueprints are clearly printed on heavy paper 15 by 22 in. In the following list the blueprint numbers are shown in italic type immediately following the descriptive title. In ordering it is necessary to give only these blueprint numbers. Where the title is followed by one number only, the blueprint is on one sheet and can be obtained for 25 cents. Wherever there are two numbers, it means that there are two sheets in the set, and the price is 50 cents. Three numbers indicate that the set consists of three sheets and costs 75 cents. In a few cases, too, there is more than one project on a sheet. A coupon is given below for your convenience in ordering. When using the coupon, be sure to enter the numbers correctly.

Airplane Models

Bremen (Junkers, 3-ft. Flying), *89-90*	.50
Combination, 20-in-1, *125-126*	.50
Lindbergh's Monoplane (3-ft. Flying), *69*	.25
Rise-off-Ground Tractor, 3-ft., *50*	.25
Seaplane, Tractor, 30-in., *87*	.25
Seaplane, Morris (Record 12½ min.), *102*	.25
Single Stick, Tractor, 30-in., *82*	.25
Tractor (Record Flight 6,024 Ft.), *104*	.25
Twin Pusher, Racing, 35-in., *86*	.25
Winnie Mae (4-ft. flying), 141-142-143	.75

Boats

Canoe, Sailing Outfit, *25*	.25
Outboard Racer, 11½-ft., *128-129*	.50
Sailboat-Motorboat, Combination (15 ft.), *131-132-133*	.75

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Bookcase, Modernistic, *88*	.25
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Book Ends, Modernistic, *100*	.25
Bookshelf, Modernistic, *100*	.25
Bookshelves, Hanging, *77*	.25
Bookstand, Modernistic, *88*	.25
Book Trough, *66*	.25
Broom Cabinet, *49*	.25
Cedar Chest, Mahogany Trimmed, *17*	.25
Chair, Rush-Bottom, *35*	.25
Chest of Drawers, Salem, *33*	.25
Chests, Treasure, *78*	.25
Clock, Grandfather, *19*	.25
Desk, Colonial, *21*	.25
Desk, Flat Top, *20*	.25
Desk, Sheraton Writing, *42*	.25
Dresser, Welsh, *60*	.25
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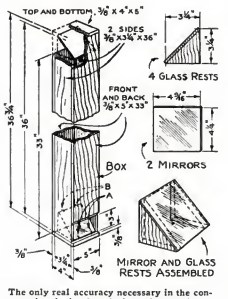
A BOY'S PERISCOPE FOR LOOKING OVER WALLS

With a periscope you can see without being seen

WHEN playing "war," "submarine," and "cops and robbers," no toy is of quite so much use to a boy as a small periscope with which to look over fences and around corners. Such a periscope is very easy to construct if two small mirrors can be obtained. It may be made of pine or other light wood, and the dimensions may be changed to suit the fancy of the maker. The only real accuracy necessary is in placing the mirrors; they must be exactly parallel.

If made the size shown, the back and front of the box are ⅜ by 5 by 33 in., the two sides ⅜ by 3¼ by 36 in., and the top and bottom each ⅜ by 4 by 5 in. The four glass rests are made to an accurate angle of 45°. Paint the inside surfaces white and assemble all pieces of the tube as shown, using glue and 1¼-in. No. 17 brads. Fit the glass rests and fasten them with ⅝-in. brads. After checking the dimensions, cut two mirrors as shown and hold them in place with ½-in. wire nails as indicated at *A* and *B*.

In using the periscope, push the tube above a wall or beyond a corner and look into the bottom mirror from the rear. You will be able to see everything within range of the top mirror.—C. K. A.



The only real accuracy necessary in the construction is in the placing of the mirrors

Improved Electrical Devices *for the* Shipshape Home

NUMEROUS improved electrical fittings are available to help the handy man with his wiring problems. Several of these are shown in the accompanying illustrations, along with a circuit diagram for turning on all the lights in a house with a single switch in case of burglary or other emergencies. These ideas supplement those published in previous articles in the series (P.S.M., Mar. '30, p. 120; Apr. '30, p. 118; May '30, p. 122; June '30, p. 107; Mar. '31, p. 122, and Oct. '31, p. 124).

Is there any simple way to arrange lights and appliances so that they will be automatically turned off after a predetermined time?

Yes, by using a new controlling device (Fig. 1) that can be set for any desired time limit. The toggle handle is used to control the lights in the usual way when the small lever at the left is in the "off" position. To make the switch automatic, the lever is set to "on" and the toggle

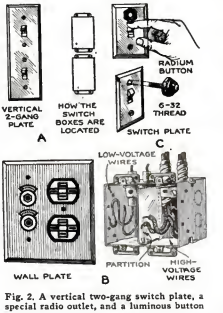


Fig. 2. A vertical two-gang switch plate, a special radio outlet, and a luminous button

handle is turned to the "off" position. The lights will then remain on until the time limit is reached. This is fixed by rocking the toggle lever back and forth, each movement increasing the time limit the amount recorded in the small window above the lever at the left. Three models are made —for timing seconds, minutes, or hours— and these are in two forms, one for lights alone and the other for small appliances. The device will fit in any standard flush-type switch box.

In a wall space which is limited in width to the space of a single gang switch, how may a two-gang group be placed?

Special plates (*A*, Fig. 2) are obtainable for mounting the switches one above the other. Care must be taken to leave sufficient lath for the screws of both boxes at the point between the boxes.

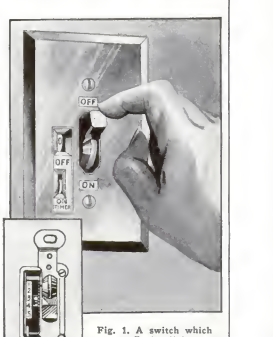


Fig. 1. A switch which turns off the lights at a predetermined time. It is also obtainable with an outlet for appliances

Can a radio outlet be combined with a convenience outlet under one plate?

Yes, if a special partition (*B*, Fig. 2) is used, as called for in the "Code," to separate the low-tension wires from those of 110 volts. This partition is made of cadmium plated steel of No. 14 gage thickness and fits in a regular receptacle box made up in two-gang formation. It can be placed in position either before or after the box is installed in the wall. The outlet provides a double plug connection for lamps or the electric radio, and the antenna and ground terminals.

How can the switches be found without feeling along the walls in the dark?

The top screw of the switch plate is removed, and in its place the special radium button shown at *C*, Fig. 2, is turned in. This makes a beacon in the dark. It is especially needed in switch locations near the top of a flight of stairs where feeling for the switch may cause a fall.

What is the easiest method of testing the various cords, appliances, fuses, and circuits around the house?

A new type of neon tester is handy for this purpose. Although little larger than a fountain pen, it gives a brilliant red light from a tiny neon bulb in the top when connected in a circuit. Some suggested uses are shown in Fig. 3, on the following page.

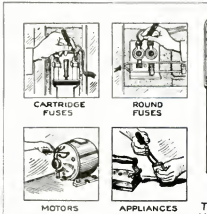


Fig. 3. A tester with neon light for checking circuits, motors, cords, and appliances

If one wishes to place a single or double plug outlet in the basement, what is the easiest way?

By means of new junction box covers with plug outlets, either single or double (Fig. 4). These make handy fittings for cellar use on exposed boxes, and they comply with all rules.

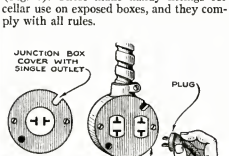


Fig. 4. A new type of junction box fitting provided with single or double plug outlets

What is the wiring plan for a burglar lighting circuit which allows all lights to be turned on from one point?

Such a circuit diagram is given in Fig. 5. The lights in dining room, living room, library, kitchen, and halls may all be instantly turned on from one single-point switch *A* in the owner's chamber. It will be noted that three-point switches *B, C, D,* and *E* are used for individual room

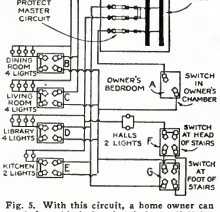


Fig. 5. With this circuit, a home owner can reach from his bed and switch on all lights

control rather than the usual single-pole variety; and for the usual three-point switch in the lower hall is substituted a four-point switch *G*. The wiring is simple, but it must be borne in mind that the circuit is intended for use with not more than sixteen lamps.

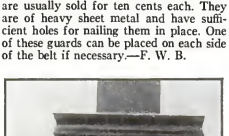
Is there any simple way to carry an extension cord under a rug?

By means of a so-called "under-rug" extension cord, this can be done safely and easily. The extension, as shown in Fig. 6, consists of a flat, pliable rubber strip 1 in. wide with two bakelite outlets and a short extension cord and plug. —HAROLD P. STRAND.

Fig. 6. An "under-rug" extension cord

POWER BELTS GUARDED BY HOSE HOLDERS

CLUMSY homemade guards are often placed around a power belt which passes through a floor or partition. Much neater and more practical floor guards can be made from inexpensive metal garden hose holders of the type illustrated. These are usually sold for ten cents each. They are of heavy sheet metal and have sufficient holes for nailing them in place. One of these guards can be placed on each side of the belt if necessary.—F. W. B.



This inexpensive garden hose holder makes a neat floor guard for an exposed power belt

FOOD KEPT COLD IN BOX HUNG ON STORM DOOR

IF A STORM door is used at the kitchen entrance of a house, the space between it and the regular outside door can be used to good advantage during the cold months of the year to keep milk and butter as cool as if in a refrigerator. A receptacle of thin boards can be made and attached to the inside of the storm door, below the latch. Provided this box is made slightly less than 4 in. wide, the inside door can be closed, it will usually be found, without interference. The space available will be sufficient to take a milk bottle, a package of print butter, and a small quantity of meat—all that a small family is likely to require—and in many cases the door arrangement is more convenient than using a window type of cold box.—L. B. ROBBINS.

TINY MODEL OF *AKRON* SHAPED FROM BLOCK OF BALSA WOOD

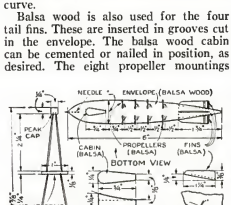
WITH the Navy's new 785-ft. airship *Akron* completed and now making its trial runs, an airplane model enthusiast's collection is no longer complete unless it contains a model of this giant scouting cruiser of the air. The model

The mooring mast for the small *Akron* model is made of toothpicks and scraps of wood

illustrated, with its realistic mooring mast, is extremely easy to construct from scrap pieces of wood.

The cigar-shaped envelope can be whittled from a 1 by 1 by 6 in. balsa block. First, draw two profiles on a sheet of paper, sketching in the outline according to the dimensions in the drawings. Then glue these profiles to the top and side of the block and with a razor blade trace the outlines so as to mark the surface of the wood. When the paper has been removed, the lines on the wood will serve as guides in whittling. In shaping the envelope, whittle to the outlines on the side and top and then round off the corners to give a smooth, continuous curve.

Balsa wood is also used for the four tail fins. These are inserted in grooves cut in the envelope. The balsa wood cabin can be cemented or nailed in position, as desired. The eight propeller mountings



Dimensions for the model and mast. The propellers are mounted on stiff wire supports

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(no power cars are used on the *Akron* as the engines are mounted inside the ship) can be formed from fine wire, cement being used to hold the various parts together. The mountings are attached to the envelope by means of holes drilled to receive the ends of the wires. A drop of cement in each hole will hold the wires in place.

The mooring mast is composed of three platforms, a peak cap, and a dozen girders. In order to make the mast heavy at the bottom, have the bottom platform thicker than the rest. The girders can be made from toothpicks which are sunk 1/4 in. deep into the four corners of each platform and cemented in place.

The model is attached to the mooring mast by means of a needle 1 in. long, which is thrust into the envelope so that only 1/8 in. projects. This projecting end fits into a small hole drilled in the peak cap of the mast.

Paint the airship aluminum and add the conventional red, white, and blue stripes at the ends of all four fins. Use black or dark blue to indicate the cabin windows. For contrast, the mast may be painted black.—EDWIN T. HAMILTON.

INLAID BANDS DECORATE MODERN TABLE LAMP

THIS modernistic black walnut lamp is simple to construct and gives the home craftsman an opportunity to use the decorative inlaid bandings now available.

The upright, which is 11 1/2 in. long, is made of two pieces of 3/4 by 1 1/2 in. stock glued together after they have first been grooved to allow a piece of 1/8-in. pipe to run through the center. A recess 3/4 by 6 1/4 in. is cut into each face deep enough to take a piece of contrasting veneer. When the veneer has been glued in place and allowed to dry, holes are bored as shown and filled with colored wood composition of the plastic type sold in tubes and cans.

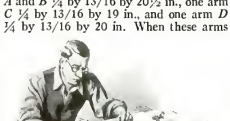
The bottom molding is merely a piece of 1/2 by 2 in. stock inlaid with a strip of banding and beveled on one edge. The top molding is made by gluing a piece of walnut veneer to a piece of light colored wood 3/8 in. thick and afterwards cutting shallow grooves to allow the contrasting wood underneath to be seen. Both moldings are mitered around the upright piece. The base is an octagon 7 in. across. It is bored in the center for the pipe, and a piece of banding is set into the edge.

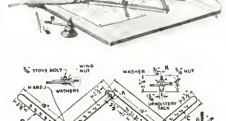
The pipe is secured at the bottom with a lock nut and at the top with a two-light fixture. The finish consists of a coat of boiled linseed oil and a number of coats of thin shellac to give a smooth surface. Each coat is rubbed with fine steel wool, and the final coat with rottenstone and oil, and last of all with ordinary furniture polish.—JOHN M. CHITTENDEN.

HOMEMADE PANTOGRAPH ENLARGES DRAWINGS

BESIDES being a useful tool for the mechanically minded reader who has occasion to enlarge or reduce shop drawings or photographs, the simply constructed pantograph illustrated is an aid to school children who wish to enlarge or reduce textbook illustrations and maps.

From some moderately hard wood such as birch or mahogany, prepare two arms *A* and *B* ¼ by 13/16 by 20½ in., one arm *C* ¼ by 13/16 by 19 in., and one arm *D* ¼ by 13/16 by 20 in. When these arms





How a pantograph of convenient size is constructed and, upper view, the way to use it

have been shaped, drill 5/16-in. holes at *E*, *F*, *G*, and *K* in the positions indicated.

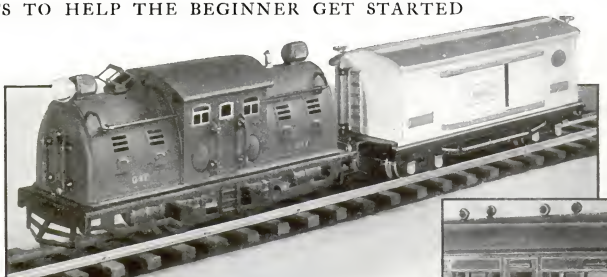
In laying out the fourteen 3/16-in. holes for the adjustable pivots *H* and *J*, adhere carefully to the dimensions given, spacing them exactly 1 in. between centers. In arm *A* the center of first hole should be placed 2½ in. in from the center of hole *K*, in *B* it should be placed 2½ in. in from hole *G*, in *C* 2½ in. in from *F*, and in *D* 2½ in. in from the end. These holes should be numbered according to the drawings with a sharp, hard pencil or, better still, a steel stamp. The adjustable pivots at *H* and *J* are made up of wing nuts, bolts, and washers; and the supporting pivot *K*, which is made of wood, should be tipped with an upholstery tack in order to obtain a smooth sliding surface.

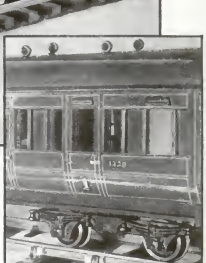
The tracing point and pencil are shown at *F* and *G*. These two should be made interchangeable so that the pantograph can be used conveniently for either enlarging or reducing. End *E* of arm *A* is attached to a 13/16 by 1 by 3½ in. wood block with a screw, and an ordinary C-clamp serves to clamp this anchor block to the drawing board.

In use, the pivots *J* and *H* are placed in sets of holes bearing the same number in order to maintain a parallelogram. The proportion of enlargement or reduction is obtained by measuring the distance from the center of *E* to *F* and from *E* to *G* and dividing them one by the other. The result shows how many times larger or smaller the copy will be as compared to the original drawing or photograph.—A. C.

Model Railroad Tracklaying

HINTS TO HELP THE BEGINNER GET STARTED





By THOMAS W. ARNOLD

TWO important questions confront the beginner in model railroading. The first is what gage to adopt, and this was discussed at length last month (P. S. M., Nov. '31, p. 106). The second is what kind of track to use.

In "O" gage, for which the greatest variety of material is available, the least expensive track is the sheet steel, tin plated type made by American manufacturers. This track appeals particularly to those model railroad enthusiasts who cannot afford the time or expense of laying steel or brass rails on wooden ties, a system that gives a fine looking and smooth running outfit but takes a lot of time.

If you want to lay your own track on ties, you can buy steel rail of American type in 3-ft. lengths for eight cents a foot, which means sixteen cents a foot for the two rails. In addition you will have to buy wooden ties at the rate of a dollar a hundred or else cut them yourself. And if you wish an electrically operated system, there is the additional cost of third rail at five cents a foot, plus "chairs" to hold it at twenty-five cents a dozen. It is also possible to buy this type of track all made up in 3-ft. lengths, mounted on a material that represents road ballast, at $2.75 a yard. Plain switches cost about $8.50 each.

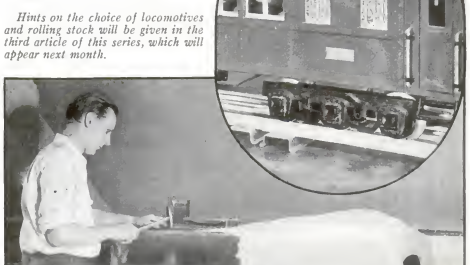
Sheet steel track of the type first mentioned costs about seventy cents a yard in "O" gage or seventy-five cents in "standard" gage.

Of course, the greatest advantage of track assembled by yourself from the rails and ties is that you can make it to any curve or formation you desire. It is also possible to construct elaborate double crossovers, or, in fact, to duplicate in miniature any track arrangement found on a regular railroad. In the sheet steel track you are limited to one radius of curve or switch, and no special varieties are available at any price.

As far as appearance is concerned, it is obvious that the home assembled track looks more like the real thing than does the tin plated variety. It is, however, possible to improve the appearance of the tin plated rails by painting them and by adding dummy ties to fill in the spaces between the sheet steel ties.

There also is a choice in the type of rail available for home tracklaying. You can get either rail of American cross section to be held to the ties by tiny nails used as spikes, or English type rail made of brass which is mounted on the ties by means of "chairs" as on full sized English railroads.

Hints on the choice of locomotives and rolling stock will be given in the third article of this series, which will appear next month.



Top view: **"O" gage brass rails.** ***Second:*** **English rails held in "chairs" by wooden wedges.** ***Third:*** **"Standard" gage tin plated track.** ***Bottom:*** **Making scenery from screening and plaster**

HALL CUPBOARDS SUPPLY EXTRA STORAGE ROOM

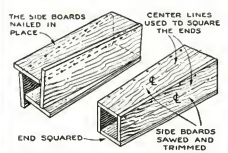
TWIN portable cupboards constructed as shown are used on each side of a window in the third floor hallway of an old house to increase the clothes closet facilities. Each cupboard consists of a bottom section containing four drawers and an upper compartment with two shelves

This light, sectional cupboard is made of scrap lumber and panels from packing cases

for towels, sheets, and hats. The panels used in constructing the cupboards were taken from old packing cases, and each section is light enough to be lifted easily by one person.—H. JERVEY.

A QUICK WAY TO MAKE TAPERING POSTS

TO BUILD up a square, boxlike, tapered post is a job that may give the amateur woodworker some difficulty. When I recently had to construct a porch post of this type tapered from 8 to 12 in., I did not shape the four sides and then assemble them, but first nailed them together as shown and afterwards ripped and planed off the projecting edges. In this way I had the advantage of the straight milled edge of the lumber for making tight joints. In order to mark the ends of a post of this shape for cutting them off square, work from a centerline.—JOHN L. SMITH.



The two steps in constructing a porch post with a taper from four rectangular boards

HOW TO BUILD A PRIZE WINNING MODEL

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correct, another five points were scored.

Some of the templates measured not one but several items, both dimensions and angles. For example, a single template sbowed at a glance whetber the distance from the floor to the bottom edge of tbe door was correct, from floor to belt line, from floor to door bandle center, and from floor to bottom of window opening. Eacb of tbese four items scored two points.

WHEN it came to wood craft, there were seven divisions relating to wbeels, body, pole, tonneau block, rear axle and footman's board, front axle and front gear, and general woodwork. In the case of the body, for example, the judges had to answer tbese questions: Is the front and rear of tbe body above the belt line slightly rounded? Are there seven neatly made molding plates on each door? Are tbe body moldings neatly made, do they stand out clear and sbarp, and are the joints well made? Are the body molding spirals evenly spaced with tbe correct right and left twist? A perfect score for all this gave a model eleven points.

Similarly, the metal work was studied under seven different beadings. In just one of these divisions—that relating to clips and brackets—eighteen separate items bad to be checked. The upholstery, painting and finishing, and the metal castings used throughout were examined with equal care.

Three judges, aided by the set of templates, were able to score a model in balf an hour, but in choosing the four best coacbes to decide the national award winners, it was found necessary to recbeck a number of the best models ten times. In one case a guild official quietly slipped the master model into the group, but it was spotted by tbe judges almost at once, althougb not many points separated it from tbe best of tbe boys' models.

Forewarned as to how a really fine model is judged, every model maker should see tbe necessity of keeping eacb part exactly to scale as be proceeds—no matter what model be is building. He can be bis own judge as he goes along and mentally rate himself on every part he makes and every operation he performs. By taking tbese precautions he can hardly fail to turn out a noteworthy model, or if be doesn't, he will at least know the reason why and be able to do better the next time.

ONE trait all tbe winners of the coach competition displayed to an extraordinary degree was ingenuity. Wbenever they ran into difficulties or could not obtain the materials or tools they needed, they found a way out by using their wits. One boy did his work on an ordinary card table on the front porch; another worked on a flat-top desk in his bedroom. One contestant cut down a tree for wood and kiln-dried it in the oven of the kitchen stove. A boy who was stumped when it came to soldering delicate parts made himself a soldering outfit by embedding one of his mother's thimbles in a wooden block and using it as an alcohol lamp.

Raymond S. Doerr, 19, of Battle Creek, Mich., wbo earned one of the four national awards—each a university scholarship—told the guild officials he spent 2,160 hours on his model. He bad previously gained invaluable experience, be said, by working on a model of the *Diamond Tally-Ho*, which was the first of the POPULAR SCIENCE MONTHLY series of coach models (shown in our Blueprints Nos. 115, 116, and 117 in the list on page 110). To build his Napoleonic coach he made a number of punches and special tools, and all these he skillfully tempered in *(Continued on page 121)*

HOW TO BUILD A PRIZE WINNING MODEL

(Continued from pa

...is home. ...kegan, Ill., ...approximately ...amplified much the furnace and the special jigs and Albert W. Fisch... workshop machines ...jig saw, and lathe. another national... ...nuity was in making 1,000 hours... ...ding to ornament the ...

of the ...er two copper wires," he attach... them in a shallow groove ...of wood. Then I filed away ...of them to give a flat surface. ...o this flat part a strip of thin ...tly wider than the twisted wires. ...is on an anvil to serve as a form ...aced over it a strip of annealed brass five thousandths of an inch thick. Then I stamped the brass into shape by using the end grain of a block of hard maple and a machinist's hammer. The excess brass was trimmed off with scissors, resulting in a perfectly formed, easily made rope molding."

DONALD C. BURNHAM, 16, of West Lafayette, Ind., who also gained one of the four university scholarships, did his work in a small hasement and used no power tools except a small lathe. It is interesting to note how differently he attacked the same prohlem of making moldings.

"I made the body moldings," he explained, "by filing little dies out of nails and stamping the moldings out of very thin brass. I then cut out the molding and soldered the tips of pins on the back of it. I stamped the top shell ornament in the same way, then cut it out with hutton-hole shears and filled the back with solder. When I poured in the solder, I put a pin in each shell. Then I drilled holes into the top molding and wedged the pins of the top shell ornament into them."

The winner of the remaining scholarship, Howard Jennings, 16, of Denver, Colo., showed equal ingenuity although he had no previous experience in model making.

A second competition on a larger scale and offering prizes valued at $75,000 is now heing conducted by the Fisher Body Craftsman's Guild, which gained an enrollment of more than 145,000 as a result of its first competition. Under the guild regulations, however, boys who entered the first competition and wish to continue their membership will have to renew their enrollment. The new competition has a wider scope than the first because Canadian boys are eligible for it. The main prizes will again he four university scholarships of four years each. The problem will be to construct the same Napoleonic coach from plans provided without charge to all memhers of the guild.

In sponsoring the guild, the Fisher brothers were influenced hy the fact that they themselves had risen from forge and bench. Their grandfather, Andrew Fisher, who had a small blacksmith shop in Peru, Huron County, Ohio, taught his two sons, Andrew and Lawrence, the trade. The two boys later set up a shop at Norwalk, Ohio, where they huilt carriages. Lawrence was the father of the present Fisher brothers. Of these Fred, the oldest, went to work at his father's bench when he was fourteen, and at the same age Charles was busy helping his uncle at the forge. The other brothers—William A., Edward F., Lawrence P., and Alfred J.—all worked in the shop. All have continued their interest in craftsmanship, and William A. Fisher is directly engaged in the guild activities as its president. The movement, indeed, was a logical development of their desire to encourage the hoys of today to work skillfully with their hands.

BIG FORTUNES WON BY TINY INVENTIONS

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not involve invention. But it was an invention nevertheless, because it was the simple means of solving a problem which Young had perceived; namely, how to make you and me play the piano like Paderewski. "Putting the great and the little thing together," said the court, "constitutes invention."

I enjoy the doubtful distinction of having turned down the patent application of William M. Folherth, who devised the automatic windshield wiper, which I now realize is an excellent example of a successful invention produced by merging two older mechanisms.

ALL Folherth did was to put automatic control valves in the existing windshield wiper motor, which utilized the reduced pressure of the carburetor intake. Up to this time, the valves of all windshield wipers had been operated by hand. The automatic valves Folherth adopted to make the operation continuous were the conventional type used in fluid-operated motors.

I rejected the application because I felt there was nothing new in this, and that Folherth had merely put two and two together. Fortunately for Folherth and for all motorists who drive their cars on rainy days, others took a broader view. The Board of Appeals reversed me. The patent was granted, and later was sustained in an Illinois court. Automotive engineers at first ridiculed Folherth's idea. But the inventor, a German immigrant, I believe, had the last laugh. After manufacturing and marketing $394,000 worth of the cleaners himself, he sold the rights to his device for several millions of dollars.

One of the most remarkable instances of a patent being attacked because the device was only a slight alteration of an older contrivance was the famous Lenke cargo beam case. The peculiar feature was that the United States Government which, of course, had granted the patent, was infringing it. This was one of the few patent cases ever to reach the United States Supreme Court, and one of the last decided by the late Chief Justice Taft. The Government lost; Mr. Taft upheld the inventor.

CARGO beams used prior to 1917, when Melchior Lenke, of Brooklyn, N. Y., patented his improvement, consisted of two beams, spaced several inches apart, firmly riveted together at top and bottom, and rigidly fixed at either end to two uprights. These beams, used for many years, weighed 3,300 pounds.

Lenke made two small but highly ingenious changes. He substituted for the heavy two-piece beam a single I-beam weighing only 1,300 pounds. Then he provided it with a pivot at either end. These improvements had three great advantages. Because it was a ton lighter and pivoted besides, the new beam was much easier to handle in loading and unloading cargo. Secondly, there was much less strain on the beam, since the pivots permitted it to turn always in the direction where the load was taken. Thirdly, there was a saving of $130 in the installation of each beam, the price of 2,000 pounds of metal at 6½ cents a pound.

The Lenke beam, though a patented invention, was adopted by the U. S. Government for use on its piers, docks, and boats. The inventor sued the Government. Court after Court upheld the United States, whose attorneys claimed that Lenke had made no invention at all, but *(Continued on page 123)*

A definite program for getting ahead financially will be found on page four of this issue

BIG FORTUNES WON BY TINY INVENTIONS

(Continued from page 122)

merely modified an old mechanism. Lenke did not give up the fight, and his persistence finally was rewarded by Chief Justice Taft's decision. What Mr. Taft said, in so many words, was that the new invention only seemed an easy and natural modification to others, once Lenke had had the intelligence and imagination to think of it.

THAT is the crux of the whole problem. There is nothing new under the sun—except ideas. Thousands of people had seen tree trunks floating down streams before it occurred to someone to build a boat. Thousands, too, had observed that a small portion of a leaf seen through a dewdrop appeared enlarged, but it was not until many centuries later that a genius thought of using the principle in the microscope. Entire races had watched clay harden in the baking sun before somebody had the bright idea that pottery could be made in that way.

Accidents? Perhaps. But the history of invention shows that such "accidents" happen only to those who deserve them; that is, those whose minds are prepared for them. In this connection, it is interesting to recall that the very word "invention" connotes the accidental. It is derived from the Latin *invenire,* meaning to come upon, or to light upon.

The original "accidents" usually did not produce the finished articles as you and I know them. Few inventions have sprung, fullfledged, from the brains of their inventors. As this is written, a patent is pending on an improvement that hinges on nothing but a little notch. Those among you who use a safety razor probably have noticed that the manufacturer of a well-known make recently put on the market a new blade with a notch at each of the four corners. This removes the parts of the blade that are grasped by those portions of the blade-holder where the little prongs are most liable to be bent when the razor is struck against the washbowl or dropped on the floor. The notches, according to the manufacturer, thus prevent the blade from cracking or being thrown out of perfect alignment. They also eliminate the ends of the blade that frequently cut the user's ear on the downstroke at the side of the face.

PERHAPS the most effective improvement produced by the smallest physical change is that in the phonograph record. Edison invented the phonograph, and in his original machine, sound was reproduced by a needle traveling through a groove that ran "up hill and down dale." The present phonograph record, however, is based on an almost microscopic adjustment patented by Emile Berliner. He made the groove of uniform depth and cut it laterally so that the needle, instead of going up and down a range of tiny hills, follows a path like a winding road. This change, almost invisible to the naked eye, worked wonders in the phonograph. The lateral groove permitted the use of cheaper records that were more easily made and yet would stand more playings. Above all, it amplified sound volume and, by eliminating distortion, improved reproduction.

Berliner's fame, incidentally, rests entirely on improvements in the inventions of others. Among other things, he invented the microphone, which took Bell's telephone out of the toy class and made it a commercial success.

It is not always necessary to make any structural (Continued on page 124)

BIG FORTUNES WON BY TINY INVENTIONS

(Continued from page 123)

change in order to perfect an invention. Take, for example the Young gas generator. Ten years ago, Daniel J. Young, an engineer of Tacoma, Wash., proposed that, in making water gas, the "run" be occasionally reversed; that is, that the steam be run through the generator from the opposite end. This idea, greeted with laughter by the gas companies, was tried out, and in less than ten years it was adopted by every gas company in the world.

WATER gas is made by passing steam through a bed of red-hot coal. The oxygen in the steam combines with the carbon in the coal, leaving hydrogen, which is made into illuminating gas by adding hydrocarbon elements from oil. Young's "back-run" process increases the production of gas from a given quantity of coal to such an extent that about ten per cent of the fuel is saved, or approximately three cents on every 1,000 feet of gas manufactured. Figure that out for all the gas plants in the world! All that is necessary to effect this saving is to pipe the steam into the former exit end of the machine. Part of the secret lies in the conversion into useful gas of carbon deposits which, in the old system, were not only wasted but had to be removed at a price. Last July, the Franklin Institute of Philadelphia conferred its much-coveted Walton Clark medal on Young for his achievement.

Similar was the famous improvement made by Henry A. Adams in the corn-shelling machine invented by his father, Augustus Adams. In the father's machine, the chute into which the ears of corn were fed was often clogged up, despite the fact that rotating fingers had been provided to push the ears downward. A farm hand usually was needed to clear the chute by punching the ears with a stick. Henry Adams merely rotated the fingers in the opposite direction, and any corn farmer will tell you that no extra hand is needed today to push the ears down the chute.

Or consider Dr. Langmuir's much-discussed high-vacuum tube patent. In 1925, Langmuir was granted a patent on a vacuum tube which did not differ in any way from those invented and patented previously, except that it was evacuated to a greater degree. In other words, Langmuir succeeded in subtracting almost nothing from nearly nothing and, in a manner of speaking, patented practically nothing at all!

THIS does not mean that his invention was not useful. Quite the contrary. The higher vacuum virtually eliminated ionization in the tube. Let me explain. The operation of a vacuum tube depends on a flow of electrons from a heated cathode, or metal element, to a plate, which is another near-by metal element. That electron flow can take place only when the number of air molecules in the tube is reduced to a point where the electrons have a relatively clear path. If too many air molecules are present, the electrons, moving away from the heated element at terrific speed, strike these molecules and disassociate or ionize them. This ionization prevents operation of the tube as an electrical oscillator, just as a steel spring would be prevented from vibrating by wrapping cotton batting around it.

Acting as an electrical oscillator is the chief function of a vacuum tube. As devised by Lee De Forest, it forms the basis of all modern radio transmission and reception. By producing a more complete emptiness in the tube, Lang- *(Continued on page 125)*

BIG FORTUNES WON BY TINY INVENTIONS

(Continued from page 124)

muir made the electrons do their stuff with a minimum of interference from air molecules and thereby made the tube more efficient as an electrical oscillator.

For six years, the Langmuir patent was the bone of contention in a series of heated legal fights, and only a few months ago it was invalidated by the Supreme Court. While granting that Langmuir's tiny change had produced a remarkable improvement, the Court found that the idea of a high vacuum was not Langmuir's, but had been conceived by an engineer named Lilienfeld as far back as 1910.

OF ALL improvements brought about without making any change whatever in the body of an existing mechanism, the most sensational doubtless is William Eibel's perfection of the Fourdrinier paper making machine, used mostly for the manufacture of newsprint. Here an industry was revolutionized by a change even smaller than the hole in the glass-molding pipe. All Eibel did was to jack up the Fourdrinier machine twelve inches! This accelerated the down-flow of the fluid pulp to such an extent that, when the machine was speeded up in proportion, production was increased from twenty to thirty per cent. In other words, Eibel increased the output from 450 feet of paper per minute to 700 feet, and pointed the way by which paper could be turned out at the rate of 1,000 feet per minute.

This slight and almost ridiculously simple change saves from $25,000 to $35,000 on technical installation, as the same quantity of paper can be made with one-fourth less machinery, and has radically cut the price of paper. Incidentally, it has made Eibel a rich man.

Eibel's patent, too, came before the Supreme Court, and, like Lenke's, was upheld by the late Chief Justice Taft. Though the invention was "as simple as water running down hill," said Taft, it had greatly improved the art of paper making and, therefore, deserved to be rewarded with a patent.

THERE you have the story in a nutshell of how big fortunes have been won by tiny inventions. Most things appear quite easy after they have been explained, and many a man has wondered why he did not think of some apparently simple device or improvement that yielded a fortune to the one who did.

AVERAGE MAN WALKS EIGHT MILES A DAY

IF YOU walk nearly eight miles a day you are an average American in your walking habits, a recent survey shows. The amount a person walks, according to the figures obtained varies from six and a half miles daily, for the store manager, to twenty-five and a half for the farmer with his plow. The postman walks about twenty-two miles every day. A woman shopper covers slightly more than eight miles a day, and a typical housewife in a year walks as far as the distance from coast to coast.

NEW CEMENT ON WOOD

A NEW stucco cement may be applied directly to wooden sheathing, where it sticks firmly without the aid of wire mesh. It is used to give a new appearance to an old wooden building. Another use is in repairing existing stucco walls.

WHY GOOD LITTLE MEN BEAT GOOD BIG MEN

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The strength of a man's arm and shoulder muscles, it was shown, determine his pulling power. This test was made with a new apparatus, called a hand dynamometer. A simple device, it is equipped with a spring and two handles. When a man pulls on the handles with all his might, the amount of power he exerts, in pounds, is registered on a dial. Pushing power is measured by pushing the handles toward one another.

What do these tests mean to you and me? Suppose you are five feet two inches tall and weigh about 100 pounds. What should your push and pull power be? About eighty pounds for push and sixty-five pounds for pull, says the Public Health Service. If you are a stocky person of the same height, weighing 160 pounds, you ought to push 110 pounds and pull eighty-five.

In case you are about six feet tall, slender of build, and weigh only 140 pounds, both your push and pull should be lighter, ninety-five pounds and eighty pounds, respectively. But if you are a six-footer weighing in the neighborhood of 180, you should be able to push 115 pounds and pull ninety.

A CURIOUS fact which the experts were at a loss to explain was that, generally speaking, the tall, slender men had to bow to the short, stocky ones of similar weight in pulling. The advantage in lifting, which is merely another form of pulling. To test their lifting power, the men were made to grasp, at the height of their knees, a small horizontal bar connected with a chain attached to the floor. Their lifting power was registered on a dial.

The heaviest men were found to have the most powerful grip and they could "shake hands" with you to the tune of 108.48 pounds, pretty close to the maximum recorded by the measuring device, a small pear-shaped affair containing a spring. It is worked by the pressure of one hand. The man of average height—five feet six inches —weighing about 140 pounds, ought to have an eighty-five-pound grip; if he is twenty pounds heavier, it should reach ninety.

In the lung-power tests, the short, heavyset lads again were the winners. Greatest lung-action was demonstrated by the shortest men in the 150-159 pound class. This was measured by a Baumanometer, in which a column of mereury is pushed upward by the force of a man's breath. The men with the strongest lungs blew the mereury up six and three-fifths inches. If you are five feet eight inches tall, but weigh only 120 pounds, you should be able to push the mercury up five and one-third inches, but if, with the same height, you weigh 170 pounds, you ought to drive it up five and three-fourths inches.

LUNG fatigue—that is, the length of time during which a man can hold his breath —also was tested with the Baumanometer. It was measured by timing in seconds, with a stop watch, the period for which a subject could support the mereury column at a height of one inch and a half.

The final test was that of vital capacity. In this experiment, the amount of air a man can expel from his lungs after breathing as deeply as possible was measured with a spirometer. The measurement was made in liters, a liter being slightly more than one quart. This capacity, it was shown, is about equivalent to chest expansion, except that it is expressed in volume instead of inches.

The experiments proved that the average man attains his maximum strength at the age of thirty, after which it declines gradually. Lung fatigue, however, varies only slightly with age.

AGE-OLD QUEST FOR PERFECT TIMEPIECE

(Continued from page 53)

words, the ancients developed the clepsydra, or water clock.

In its simplest form, the clepsydra was nothing but an earthenware globe with several small holes in the bottom. When a lawyer, senator, or other orator started his harangue, the globe was filled with water. He was informed that his time was up when all the water had run out.

Ever since then, there has been a continuous search for more and more accurate timekeeping machinery. The hourglass of our ancestors, consisting of two glass globes connected by a small aperture, one of them filled with a quantity of fine sand, was one of the many adaptations of the classical water clock.

During the first sixteen centuries of our calendar, all sorts of complicated mechanisms were produced. They looked quite impressive, but as timekeepers they were not much better than the early water clock.

A great change came in 1583. One morning in that year, a nineteen-year-old student in the University of Pisa, Italy, attended mass in the cathedral. His mind was diverted from the service by the swinging of a lamp overhead. Timing the swings by feeling his own pulse, he found that each swing was accomplished in precisely the same period. The youth was Galileo, and that is how he discovered the law of the pendulum.

THE use of the pendulum marks the beginning of accurate timekeeping, for the first clock that made any pretense to keeping true time was provided with a pendulum. It is safe to say that the same simple mechanism also is the last word in correct time recording, for the most accurate clock in the world today is merely a piece of machinery designed to drive a most exquisitely refined pendulum.

The pendulum clock had and still has one great disadvantage—it isn't exactly the thing to carry around with one. Even before the pendulum clock was thought of, experimenters were working on portable timepieces and, toward the end of the fifteenth century, German craftsmen produced what then was considered a masterpiece—the so-called "Nuremberg egg," great granddaddy of your pocket watch.

Nearly as big as your alarm clock, the Nuremberg eggs did not amount to much as timekeepers, but they were so beautifully designed and so richly decorated as to constitute works of art. In those days, only kings and nobles had timepieces of any kind. The workman of today with only a dollar watch can tell time far more accurately than could the medieval king with one of the ornamental eggs.

Still, those monstrosities were the forerunners of the high-grade modern watch. The first great step forward was the application, near the end of the seventeenth century, of Galileo's pendulum principle to portable timepieces. The invention of the hairspring made it possible to substitute the coiling and uncoiling of a spring for the pull of gravity, so that the balance-wheel-hair-spring arrangement, introduced at that time, really amounted to a pendulum action. The timepiece thus produced reduced the daily errors of the Nuremberg eggs from half hours to only a few minutes, and the same crude mechanism, without basic change, still is used in the dollar watches and cheap alarm clocks of today.

The machinery that makes a really fine watch keep time to the second is not as simple as that. *(Continued on page 128)*

QUEST FOR PERFECT TIMEPIECE

(Continued from page 127)

Nearly all of the tremendous effort expended to reach present-day perfection has centered on developing the escapement. This consists of the balance wheel, its hairspring, and the pallet. One forked end of the pallet engages the openly spaced teeth of the last wheel in the train, called the escape wheel, and the other end engages with a tiny jewel fitted to the hub of the balance wheel to give it the necessary hack-and-forth impulses.

A list of the men who developed new watch escapements in the past century or two would he as long as your arm. It seemed simple enough to design a sort of ratchet arrangement that would make the halance wheel swing back and forth and thus permit the gears in the watch to turn at a slow and steady rate. The rub came in trying to do this in such a way that the halance wheel could swing hack and forth freely like a pendulum without having the mechanism interfere with its heating.

The modern watch escapement is a refinement of a so-called lever escapement worked out by Thomas Mudge, English horologer, more than 100 years ago. Mudge's lever escapement and Earnshaw's split halance wheel made the modern precision watch a possibility. Until elinvar was discovered, there had been no hasic improvement in watches. In theory, the thin, ultra-modern watch of the last few years is exactly like the heavy, biscuitlike timepiece your grandfather carried.

IF THE early watch experts had realized the magnitude of the task before them, they would, perhaps, have given up in despair. The effect of temperature seemed the greatest prohlem to solve. Yet its partial solution showed the watchmakers that there were other difficulties that applied to portahle timepieces and not to stationary clocks. That point in the development of timekeeping machinery marked the parting of the ways for watchmakers and clockmakers. From then on each group's methods of tackling troubles hecame totally different.

The clockmaker, when he found that a certain condition was causing his clock to err, let the clock alone and tried to rectify the condition. The watchmaker, on the other hand, accepted the condition and tried to make his watch compensate for it.

Today's most accurate clocks are Galileo's pendulums refined to the utmost and operated under conditions that do not vary a hair's breadth from year to year.

Mounted on huge concrete hases to eliminate vibration, kept in rooms where the temperature and even the humidity and air pressure never are allowed to change, watched over by experts, it is small wonder that they give an excellent account of themselves. Such clocks run with an error of only two-hundredth of one second a day—some even with less.

The poor pocket watch is suhject to changing temperature, vibration, changing position, and other handicaps. Hence, no pocket watch could ever rival the hest clocks for timekeeping. Yet, in view of the conditions under which a high-grade watch must operate, its performance is a trihute to man's skill in building precision machinery. A really first-class watch will frequently keep time within half a minute a month; and sometimes, for long stretches, it will do even better.

Aside from the effects of temperature, there are two other important causes of timekeeping error. One of these is the changing tension of the main spring as it runs down. This defect was recognized by the early watch experts, and they worked out an elaborate and cumhersome system to correct it. If your great-grandfather owned a really fine pocket timepiece, it doubtless had in it a tiny gold chain that was wound into spirally arranged grooves in a wheel. This chain transmitted the power of the main spring to the first gear in the train and, as the spring ran down, the chain rolled off a higher and higher groove, thus changing the leverage with which the spring's power was supplied. This queer contraption was called the fusee. It is no longer used.

Instead, watchmakers now make the main spring longer and taper it in such a way that there is relatively little difference in its strength for a twenty-four-hour run. Then they adjust the halance so that a slight change in the length of the swing will not change the timing of the swing.

This is called the isochronism adjustment. Because it neither is ahsolutely perfect nor holds good heyond a twenty-four-hour run, it is advisahle to wind a watch at exactly the same hour each day.

The other important source of watch error is changing its position. Ordinarily, a watch may be placed in five different positions either in your pocket or on your bureau. The normal position, with the winding stem up, is one, hut it may tip over either way in your pocket, so that the stem points to right or left. That makes two more possihle positions. Then you may place it on your hureau at night either face up or face down. That makes five positions in all.

Since the halance wheel of a watch really is a form of pendulum, it is affected by gravity as well as hy the tension of the hairspring. If it is not in ahsolute balance around the axis of its huh, the effect of gravity will he greater in one position than in another. A fine pocket watch, therefore, is adjusted for and tested in all five positions.

Here, too, a complete elimination of errors is not humanly possible. The United States Bureau of Standards, in testing watches of the railroad precision class, allows a tolerance amounting to a difference in daily rate of five seconds between dial-up and dial-down positions. Thus, it is easily seen why a fine watch at all times should he carried in one definite position, preferably winding stem up. If you want to go in for further refinements, hang it up at night.

PALACE BURGLAR ALARM GUARDS CROWN JEWELS

A NOVEL hurglar alarm protects the Danish crown jewels, which can he seen by the public in the palace of Rosenborg at Copenhagen. Should a person approach too closely the case of priceless jewels, an invisihle alarm immediately sets off an ear-splitting outhurst of bells and sirens. All doors to the chamher instantly close and lock automatically, and the cabinet containing the jewels sinks through a hole in the floor and disappears. Not generally known, the existence of this alarm system was revealed only recently when an unwary guide with a party of tourists accidently set it off. An attendant in the room drew his revolver and ordered everyone to stand where he was, while carloads of police rushed up and surrounded the castle. Explanations satisfied the police, and the tourists and their guide were allowed to go on their round of inspection.

HOW NAVY PLANES LAND ON CARRIER'S DECK

(Continued from page 58)

their call to planes, a large board on which are hung metal cut-outs, replicas of the several types of planes. Thus, by sticking the cut-outs on the board, the pilots can determine without actually filling the 880-foot deck with airplanes just how many planes will fill a given area and in what positions they should be lashed down.

While the carriers are intended to carry on the flight deck and be able to launch seventy-two planes, on one occasion the *Saratoga* had jammed on that broad expanse more than one hundred bombers, scouts, and fighters. The entire group was so arranged that all could take off under their own power! That is, it was not necessary to discharge any from the catapult.

Of course, the fighters, weighing little more than a ton, can rise after a shorter run than is required for the scouts. The bombers need even more room. But all have the advantage of an initial wind velocity of twenty to thirty miles an hour as the carrier boils ahead.

In the early days of carrier flying, take-offs and landings were more complicated than today. Then before a plane took off, it was hooked firmly to the deck while the pilot raced his engine. When the propeller finally was turning fast enough to lift the plane's tail from the deck, the hook was released and away the ship sped. Now, the take-offs are normal in every respect with no trick gadgets to aid.

ALSO, in the old days of 1928 there was no apparatus on the flight deck that not only halted the planes' forward movement, but also kept them from skidding sideways. This was found to be unnecessary, as each plane, through a trick in the arresting gear, tends to "hunt" the center of the deck.

Some pilots think the day will come when they will dash down from a long patrol, hit the deck on three points, pull on the brake, and stop without any external aid. Already this has been accomplished as an experiment. The late Lieut. T. G. Fisher, killed last summer when his fighting plane dove into the Pacific while dropping dummy bombs on the radio-controlled destroyer ex-*Stoddert*, landed on the *Saratoga* without the help of the arresting gear.

Since it was a test and had not been attempted before, the deck was cleared of airplanes and the "crash barrier" was not erected. As the *Saratoga* steamed into the wind, Fisher swept in, landed on the ramp, and with his brakes slowed down his plane.

I saw a French instructor at Rockwell Field during the early days of the World War test the air by holding up a wet finger. If even a slight beeze cooled one side of his finger there was no flying that day. Now the carrier pilots fly in all sorts of weather, sometimes landing in a rainstorm.

THEIR jobs demand that they be able to find their way around the ocean not only during inclement weather, but also to fly long distances from their ships. A hundred-mile jaunt either for a single scout or a whole squadron is only an incident in their flying lives.

Occasionally pilots become lost. Even though from an altitude of 5,000 feet they can see a carrier thirty-five miles away on a clear day, in a haze a carrier becomes a tiny spot on a vast expanse of sea. At such times an extra dose of oil on the fires sends a heavy cloud of smoke billowing upward. On a calm day, the smoke rises to a great height. A pilot can see this black streamer fifty miles away.

TWO MILLION SHOTS IN BATTLE OF EXPERTS

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before they had descended to the ground.

If you were to visit Camp Perry two weeks before the opening of the National matches, you would find a group of soldiers, men from the Signal Corps school at Fort Monmouth, N. J., plowing furrows all over the camp. Into these they put wire—forty miles of it—and then fill in the dirt, carefully replace the soil, and smooth the ground with a power roller.

The installation of a telephone system complete enough to serve a small town is a necessary part of the matches. Without telephones, the range officers on the firing lines could not communicate with the men in the concrete pits who indicate, by means of large colored disks, the position of each shot and then paste it up so there will be no confusion when the next shot arrives. Eighty telephones, on forty lines, are required to handle the range activities. These are installed and maintained by twenty-seven men from the telephone division of the Signal Corps School.

At the 1931 meet, the Signal Corps group introduced something new. It installed a radio station that maintained direct contact with Fort Hays at Columbus, and thus kept Camp Perry tied into the corps radio network that covers the country.

Finally, after the matches are over, the telephone men spend three days digging up the wires, replacing the earth and sod, and carefully rolling them down, dismantling the radio station, and packing the equipment.

THERE has been a mistaken belief that the Camp Perry matches are maintained only for the military man, and that the outsider has no business there. Anyone, even if he never had a gun in his hand before, will find a welcome, a gun, ammunition, and a tent awaiting him; and a number of events which he can enter. The school is maintained largely for such beginners.

Although the Army does most of the housekeeping at the matches, officials of the National Rifle Association are present in force. The numerous contests represent the culmination of much of the year's work of the Association. Just now, there seems to be an increasing interest in shooting as a sport. The Association officials feel happy about this because they believe that the present-day crime situation would disappear almost overnight if every reliable American citizen were to take up shooting, particularly with pistol, so that he would be able to defend his property and his family. The presence of many women on the firing line at Camp Perry indicates that Miss and Mrs. America are capable of defending themselves if given the opportunity and the sanction of state governments.

BIG DOCK EMPTIED TO SAVE KITTEN'S LIFE

A VENTURESOME kitten and a flock of exhausted swallows gave rise to a pair of oddities in the month's news. The kitten, exploring the immensity of the floating dock at Bristol, England, had the misfortune to become imprisoned in a drain. To release it, eleven million gallons of water were emptied from the dock. Then a police sergeant rescued the kitten. Meanwhile, at Vienna, thousands of swallows fluttered weakly to the ground, prevented by hunger and exhaustion from continuing their southward migration over the Alps. A radio appeal was broadcast, and bird lovers, hastening to the aid of their feathered friends, gathered the swallows in wooden cages. These, transferred to airplanes, were carried swiftly across the Alps.

GENIUS OR IDIOT?

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body changes. When a lack of this hormone occurs, the individual grows little during childhood and usually stops growing altogether at an early age. As a rule, this kind of dwarfism is accompanied by obesity. Many of the short, chubby people you meet are mild cases of pituitary deficiency.

MR. MOK: How about giants?

DR. RUCKES: A giant is the exact opposite of this second kind of dwarf. Gigantism is the result of an over-abundance of this fluid from the front part of the pituitary, which makes an individual grow out of all proportion to normal without, however, changing the body form. One of the best-known, authentic cases of gigantism is that of Charles Byrne, the "Irish giant," whose skeleton is on exhibition in the Museum of the Royal College of Surgeons, in London. According to Sir Arthur Keith, the famous British scientist, it measures 7 feet, 8.4 inches in height, but in life Byrne is supposed to have stood 8 feet, 2 inches. He was born in 1761 and died only twenty-two years later. Giants usually have excessive bone formation.

MR. MOK: Why is that?

DR. RUCKES: Because the pituitary also regulates, to some extent, the formation of the bones. Of all animals, turtles have the most bone in proportion to the rest of the body. They also have the most active pituitary gland. The fact that over-activity of the pituitary is responsible for giants has been proved time and again in the laboratory. Giant rats have been produced by daily injections of pituitary fluid. One rat attained exactly twice its normal size—in other words, if it had been a man, it would have been nearly twelve feet tall.

MR. MOK: What is wrong with the fat lady of the circus?

DR. RUCKES: She is a case of excessive obesity caused by lack of pituitary fluid but unaccompanied by dwarfism.

MR. MOK: What are the functions of some of the other endocrine glands?

DR. RUCKES: One of the most interesting of the glands and one which, in the last eight years, has received world-wide publicity, is the pancreas, the producer of insulin. This is a peculiar and complex gland because it has ducts and also acts as a ductless gland. Its duct-bearing part produces digestive juices that are in no way related to endocrines. Its ductless portions are the insulin producing parts. Insulin literally means "from the islands." This refers to the small, islandlike areas in the pancreas that secrete this substance. Insulin in its pure form was extracted by Dr. F. G. Banting and Dr. J. J. R. MacLeod, both of the University of Toronto. They discovered it could be used successfully in the treatment of diabetes, though it is not a cure for the disease. In 1923, Banting and MacLeod received the Nobel Prize for these achievements.

MR. MOK: Isn't insulin from sheep used in the treatment of diabetes?

DR. RUCKES: It is, and I am glad you asked that question because it reminds me of an important feature of the endocrine glands. It is this: They are virtually interchangeable in all backboned animals, from fish to man; that is to say, they secrete the same chemicals no matter in what animal they are found. Only backboned creatures have ductless glands. Incidentally, the fact that they are interchangeable is considered by evolutionists as another piece of evidence for the relationship, and hence, common descent, of the animals, including man. First, it was discovered that thyroid extract from a sheep would cause growth changes in a frog. Then it was found that the thyroid fluid from a dogfish, *(Continued on page 132)*

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or shark, could be used in human beings and any other animal. Finally, the Banting-MacLeod experiments showed that sheep's insulin was effective in human diabetes patients. Nowadays, the chemical constitution of several of the endocrines is so well known, that some of them are synthetically produced in laboratories, among them thyroxine, and the fluid from the adrenal glands, which is called adrenalin.

MR. MOK: What are the adrenal glands?

DR. RUCKES: They are two small bodies, somewhat triangular in shape in human beings and about one inch long at the base, that form small caps on top of the kidneys. Each of them produces two kinds of chemicals.

MR. MOK: How is that possible?

DR. RUCKES: Because the adrenals are double-layered. The central core produces one kind of fluid, and the enclosing capsule, which is like the shell of a nut, secretes the other. An interesting feature of the adrenal glands is that, in proportion to their size, they have the largest blood supply of any body organ.

MR. MOK: What are these two chemicals and what are their functions?

DR. RUCKES: The fluid produced by the core regulates the blood pressure; that is, an increased amount of adrenalin in the blood causes the blood vessels to contract their walls, thereby increasing the pressure of the blood in the vessels. For that reason, adrenal extract or adrenal salts often are used to reduce or stop bleeding. The chemical produced by the outer layer regulates the reproductive glands.

MR. MOK: What do you mean by that?

DR. RUCKES: You see, the glands of internal secretion are the chemical regulators of our bodies, and they tend to balance one another chemically in some mysterious way, as I will try to explain later. Let us stick for a moment to the adrenals. When the outer layer fails to function properly, all sorts of strange and distressing changes may occur in the individual.

MR. MOK: For instance?

DR. RUCKES: Poor functioning of the adrenal outer layer explains some cases of bearded ladies, though superabundant hair growth also may be a vestige, as Dr. Gregory has told you (P. S. M., Aug., '31, p. 70). This beard is only one symptom of an *actual change in sex*. Not only does hair appear on the face, chest, and arms, but the entire body shape changes from female to male. The opposite also happens, and cases are on record of boys almost changing into girls. Similar irregularities sometimes cause the reproductive systems of children from four to six years old to mature. Usually, they die soon. A striking example of such a "compressed life cycle" is that of Thomas Hall, who was born in Willingham, near Cambridge, England, in 1741, and died there of extreme old age in September, 1747, at the age of not quite six, all wrinkled, a pathetic spectacle. On his gravestone, there is this inscription, in Latin: "Stop, traveller, and wondering know here buried lie the remains of Thomas, the son of Thomas and Margaret Hall: who not one year old had the signs of manhood; not three was almost four feet high; endued with uncommon strength, a just proportion of parts, and a stupendous voice; before six died as it were of advanced age." This premature development sometimes also is due to an abnormality of the pineal gland on top of the brain. Little is definitely known about this gland except that it once was an eye in the amphibians and the reptiles. In fact, there is one lizard living in New Zealand today that still has this third eye on top of its head.

MR. MOK: I seem to remember that some connection is supposed to exist between the production of adrenalin and fear, anger, and excitement of various kinds.

DR. RUCKES: It appears that the amount of adrenalin in the blood increases as a result of these emotions, and as adrenalin regulates the blood pressure, it is probably for that reason that we get hot or cold, red or pale, in these emotional states. Some scientists explain this connection by saying that, in case of emergency or crisis, the brain sends a message to the inner core of the adrenals which, in response to this SOS, pour adrenalin into the bloodstream. The heartbeat is speeded up, energy generated, the digestion retarded, the sweat glands begin to work, the hair stands up on end, and the man or beast in question is ready for fight or flight. But most of the present knowledge about such connections between emotions and gland activity is in the guessing stage. We do know, however, that there is a definite connection between the amount of adrenalin in the blood and physical exercise. This is because adrenalin is necessary to release the stored sugar fuel in various parts of the body, principally the liver, for the production of energy. In other words, when you exercise violently, a great deal of adrenalin gets into your blood.

MR. MOK: What of the reproductive glands?

DR. RUCKES: As I have told you, they serve two purposes. First, the production of egg cells and sperm cells; and, second, the secretion of hormones that appear to determine the secondary sex characteristics.

MR. MOK: Has the connection between these hormones and physical appearance been established experimentally?

DR. RUCKES: Certainly. A little while ago, I said that a delicate chemical balance is maintained among the various ductless glands. *The peculiar part is that all or some of the endocrine glands, in addition to their usual functions, seem to possess the ability to counteract the activities of the sex hormones.*

MR. MOK: I don't quite understand that.

DR. RUCKES: I don't blame you, for it is a pretty intricate system. I can best make it clear to you with an experimental example: If we take a normal young male goat and remove its sex glands before the secondary sex characteristics have appeared this goat will assume the secondary sex characteristics of a female goat when it reaches maturity.

MR. MOK: I agree with you that this seems to show that the sex hormones determine both physical and emotional characteristics. But isn't the result here rather a negative one—simply the absence of male characteristics? How does it demonstrate the counter activity of the other endocrines?

DR. RUCKES: This is shown more clearly in a reverse experiment, which also has often been made. *When the sex glands are removed from a young female goat, the animal, upon maturity, grows horns and a beard.*

MR. MOK: This may be true of goats—but how about people?

DR. RUCKES: Of course, surgery is not my line but I do know that hospital records show that similar changes occur in human patients. Now, these experiments indicate that the other endocrines are at work in such cases and mysteriously create the opposite attributes. Besides, it indicates that the differentiation between the sexes is not as sharp as is generally believed. Scientifically, the line of demarcation between male and female is pretty vague.

MR. MOK: Again, I am afraid that I don't quite follow you.

DR. RUCKES: I mean that in nature the sexes are not *(Continued on page 133)*

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(Continued from page 132)

divided like black and white. That is where our poor Swiss rooster comes in, which was burned at the stake for laying an egg. You see, in birds, a small part of the male sex glands is potentially female. Normally, this part is inactive. But in certain cases, it develops abnormally, and egg-laying may be the result. You remember I told you that scientists have created this condition artificially. They did this by removing most of the sex glands, leaving the potentially female portion. The secondary male sex characteristics of these birds disappeared almost entirely—the rooster, for example, lost its comb and tail feathers. That was to be expected. The wonderful feature is that, in their new female form, the birds remained fertile. In other words, these were complete sex reversals.

MR. MOK: Is a human being also potentially two-sexed?

DR. RUCKES: Only as an unborn baby. In the normal adult, only one sex is apparent. But, as I said, the dividing line is not as sharp as most of us think. There are many gradations between the 100 percent male and the 100 percent female. On the other hand, there are individuals, in the animal kingdom as well as among us, that are more than 100 percent male or female.

MR. MOK: How is it possible to be more than 100 percent of anything?

DR. RUCKES: By 100 percent male or female is meant the complete, normal male or female. In some individuals, however, the sex hormones are so powerful that they intensify the male or female secondary sex characteristics. In such cases, among people, you get the "real he-man" type and the soft, over-feminine, "clinging vine" type of woman.

MR. MOK: Are the sex hormones also responsible for youthfulness?

DR. RUCKES: They are. What we call youthfulness or the vigor of youth—such things as physical prowess, activity, rapid rate of growth and repair of the body tissues, playfulness, and last but not least, the romantic tendencies of young people and their ability to have offspring—all are due to the activities of the sex hormones.

MR. MOK: Does this mean that old age is simply the result of a slowing-up of the sex glands?

DR. RUCKES: Not entirely, but mostly. In part, it is also due to the accumulation in the cells of the body of toxic, or poisonous materials, or waste products. Since these cannot be removed, they interfere with the normal working of the cells, much as the accumulation of dirt or dust interferes with the operation of any engine. After a while, the engine stops. So do the body cells. *This is death from old age.* Now, this matter of old age, or senescence, has been carefully studied by a number of investigators, among them the late Dr. Jacques Loeb, former director of the Rockefeller Institute; Professor Gary N. Calkins, of Columbia University, and Dr. Lorande L. Woodruff, of Yale. They found that the lowest forms of creatures that have the sex method can rejuvenate themselves.

MR. MOK: How?

DR. RUCKES: During most of their lives, these creatures, as I told you last month, reproduce themselves by self-division. When they got old—that is to say, when the one cell of which they consist becomes clogged with waste materials—they get sluggish and, unless they mate, they die. Such mating does not produce offspring in the ordinary sense.

MR. MOK: What does it do?

DR. RUCKES: It rejuvenates the worn-out cells. The strange *(Continued on page 134)*

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part is that both the tiny creatures that mate are old and worn out, and that both are young after mating.

MR. MOK: What of rejuvenation among people? Can it really be accomplished?

DR. RUCKES: Yes, indeed it can. Since old age in the higher animals, including man, is chiefly due to deficiency of the sex hormones which, you remember, produce the secondary sex characteristics, including youthfulness, new youth, or rather vigor, can be instilled in two ways.

MR. MOK: What are they?

DR. RUCKES: The first method involves transplantation of the sex glands from one animal to another, or from an animal to a person. You recall that the endocrine glands are interchangeable in all backboned creatures. The second method, which is used by the famous Dr. Voronoff, and Dr. Steinach, is more intricate. It consists mainly in causing the sex gland to rejuvenate itself.

MR. MOK: How is that done?

DR. RUCKES: The sex gland is prevented from fulfilling its primary function; namely, the elimination of sperm cells or egg cells. What happens then is this: The glands go on secreting these cells just the same, and the stored-up cells produce more of that part of the sex gland that secretes the hormones which, in turn, are responsible for the secondary characteristics, including youth.

MR. MOK: As I understand it, the first method you described is what is known as a "monkey-gland" operation?

DR. RUCKES: Yes, but it need not be the gland of a monkey. The glands of sheep and of other animals are also used. The reason it is called a "monkey-gland" operation is that the first transplantation on human being was performed with a monkey gland.

MR. MOK: Does it make any difference where the animal gland is inserted?

DR. RUCKES: Not necessarily. As I told you, the endocrine glands are ductless and their chemicals are absorbed by the bloodstream. For that reason, a transplanted gland makes its effect felt no matter into what part of the body it is grafted.

MR. MOK: Are these gland transplantations always successful?

DR. RUCKES: Here we get again into the field of medicine and surgery, and that is not my province. However, it is my impression that they are not always successful.

MR. MOK: Have these operations been performed on both men and women?

DR. RUCKES: They have. In both cases, the result is a rejuvenated but sterile person. Now, somewhat similar effects may be produced without resorting to surgery. Of late, sex hormones have been extracted, and they may be introduced into the system by injection or other means. These hormones are not patent medicines, and cannot be obtained without a doctor's prescription. As you know, numerous treatments pretending to restore vitality are constantly advertised. The vast majority of these are quackeries.

MR. MOK: What influences do the endocrines exert on our emotional lives?

DR. RUCKES: I have told you about some of them, but the emotions are not really in my line. I would suggest that you ask a psychologist to tell you that story.

WHY do we behave like human beings? What are the origins and mainsprings of our likes and dislikes, our desires and passions? In the January POPULAR SCIENCE MONTHLY, *Dr. A. T. Poffenberger, head of the Psychology Department in Columbia University, will take up these questions. His answers will give you the story of the emotions. On the news stands December 1.*

DEEPEST OIL WELL TWO MILES DOWN

(Continued from page 21)

Associated's Clarke No. 2 at Santa Fe Springs, Calif., recorded a temperature of 206 degrees at 7,800 feet. Seven other wells failed repeatedly to get cement to "set" over this hot formation, although one made nine attempts. Drillers finally brought in Clarke No. 2 only after circulating fifty tons of ice to chill the formation.

Extreme variations in temperature in different localities lead some scientists to believe that these fluctuations may reveal subterranean folds or trends of structure not detected through surface mapping.

Great as are the obstacles ahead, experts predict marvelous strides toward still deeper drilling in the near future. Looking back seventy-two years, to the time Colonel Drake drilled the first American oil well at Titusville, Pa., oil men recall with a chuckle the crude tools by which wells were first shoved down to the shallow eastern pools.

A WOODEN walking beam, driven by a revolving eccentric wheel, slowly jerked a manila rope up and down, lifting the bit and letting it fall sharply. A pair of chain-like links allowed a little slack in the line which, when taken up on the up-stroke, jerked the bit free from the bottom. Thus a regular oscillation was built up with the bit jumping through a wide swing and hitting the bottom with considerable force. This column of steel, five inches in diameter and forty or fifty feet long and weighing a ton or more, slowly sank a hole downward, its beveled edge chipping its way into the rock like a huge pick.

The next few years saw a number of radical changes. Chief among these was the introduction of the rotary drill, which whirled the bit down through the hardest strata with astonishing speed. Already, drillers had found that by keeping the hole full of water, the gas and oil can be kept under control until the well is ready to be brought in. Even very large producers can thus be restrained from gushing over the derrick.

So potent is the weight of this column of water that rich oil strata are drilled right through without knowledge of the drillers. In the barren, humpy Elk Hills field, one well passed blindly through a gas zone which later tipped the gage at 800 pounds per square inch. Subsequently this well yielded natural gas at the rate of from 30,000,000 to 100,000,000 cubic feet daily. In the Coyote Hills, some eighty-five wells passed through an oil sand which was later tapped by a well to yield 10,000 barrels a day.

By pumping a steady stream of mud down through the center of the drill pipe, out through holes in the bit, and back up around the casing, the restraining pressure of the heavy fluid on unruly gas zones was increased, while circulation of the mud softened the hole and kept it clean of cuttings. At the same time, drillers learned to watch the mud flowing back out of the hole until oil showings are betrayed by bursting bubbles of gas released at the surface of the mud.

ENGINEERS, who had previously placed the limit of deep drilling at the point where the buoyancy of the manila drilling cable floated the bit in the water, now saw no limit to the number of strings of pipe that could be screwed end to end to twist the drill.

Humping over the mud ditch until a strong odor of natural gas revealed the presence of the oil zones their survey had predicted, geologists earned the picturesque name of "mud smellers." Much more successful sniffing became possible with the invention of the core barrel. This peculiar type of bit, essentially a ring of (Continued on page 136)

DEEPEST OIL WELL TWO MILES DOWN

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teeth which bites out circular sections of rock much as a cookie cutter cuts circles of dough, brings to the surface cylindrical cores which are cross sections of the strata penetrated.

Correlating the data gained from the cores of a number of wells in one field, geologists now plot maps of the subterranean structures with surprising accuracy.

Ever a relentless enemy of producing oil wells, intruding water, flowing around the casing into petroleum sands and forming an emulsion ruinous to the quality of the oil, had brought many a fine well to an early end. Drillers sought to shut out this water by ending the casing in a tapered joint which they drove as tightly as possible into a solid formation, sealing the pipe against water from higher strata. Where the hole terminated in a soft formation, a sack of flaxseed was sometimes dropped to the bottom, where it swelled and forced itself up around the casing, shutting off the water to a certain extent. Lead shavings, clay, wheat, chopped rope, and many other substances were used for this purpose, but with poor success.

R. W. Stephens, experimenting on a Union Oil Company well in the Purisima field, hit upon an improved method. Dumping liquid cement to the bottom of the hole to a depth of twenty-six feet, he lowered the ten-inch casing into this plastic mixture. When the cement had set thoroughly, the hole was drilled through this plug to the oil sand. The water shut-off was perfect.

LATER, oil men learned to place a packer at the bottom and drive in the cement by compressed air, allowing it to harden under pressure to form a solid, dry joint. Today, clean holes sealed perfectly against intrusive waters permit the flow of oil and gas until the supply is completely exhausted.

Other inventions have since come rapidly to the aid of the oil man. From the terrific heat of the electric blast furnace have come Borium, Blackor, and Diamonette, materials so hard they easily cut glass. Used for facing the cutting surfaces of drills, they outwear the hardest of steels and vastly reduce the amount of time lost in changing bits. Drills tipped with disks that cut at an angle now sharpen themselves as they turn, keeping a razor-sharp edge at all times. For rock work there are bits whose cutting sufaces are toothed cones, which mill around as the drill rotates and literally pulverize the rock into dust.

Streams of salt water, leaking into oil strata, now betray their deadly presence to the "water witch," a queer instrument based upon the principle that salt water is a far better conductor of electricity than pure water. Dropped into the hole, which has just been washed clean with fresh water, this "water witch" gives a deflection upon a meter when a zone of the conducting salt water has been reached.

HOW straight is an oil well? A few years ago, oil men didn't know. An early survey indicated a drift in one well of 1,200 feet from the vertical. Drillers scoffed at the crazy instrument that had measured the hole, until, one bright morning, two wells located 500 feet apart at the surface came together. Operators began to take notice. Later, the discovery of oil at Signal Hill, just at the edge of the city of Long Beach, Calif., brought such a multitude of derricks that often adjacent rigs were so close one could not walk between them. It became a common thing for a driller to find he had penetrated the casing of a neighbor.

Another serious problem is the maintaining of the circulation of the steady flowing mud stream. When it ceases, trouble begins. Underground caverns sometimes cause grave difficulties by swallowing the down-flowing stream of mud, instead of returning it to the surface. One remarkable well—the No. 1 Crowell at Tulsa, Okla.—ran into a cave that devoured 4,400 sacks of cement without a murmur. Nine hundred barrels of lime were dumped in—and the hungry well asked for more. Next came 300 wagon-loads of red clay, but they didn't faze the well. Desperate, drillers sent out an SOS to the farmers in the vicinity.

They brought 500 bushels of oats, 180 bushels of corn, twenty tons of cottonseed hulls, and 180 bushels of bran. When an additional twenty tons of ensilage had vanished into the well, the drillers gave up in disgust and abandoned the hole.

Trying it again about a quarter of a mile to the south, they struck the same formation—evidently an underground cave of enormous size. Here they succeeded in reaming and setting pipe though the cavern, which logged 130 feet from top to bottom.

SETTING the casing in deep wells is no mean mechanical problem. Lowering a pipe weighing hundreds of thousands of pounds to a predetermined point that must be located within a few feet or even a few inches in nine or ten thousand feet, drillers must "land" the casing in a solid formation that holds the cement firmly.

Inside the casing itself hangs the tubing through which the oil flows. The weight of this long string of pipe is sometimes too great for its strength, and the tubing snaps, letting the lower portion plunge downward. A clever mechanical device is now attached somewhere upon the lower portion of the tubing. If the pipe gives way, its downward plunge is halted within five inches by viselike spring teeth that bite into the surrounding casing, checking the fall. Fishing tools snag the broken section, and the spring teeth yield to an upward pull, allowing the tubing to be withdrawn for repair.

One remarkable clever instrument was devised by an engineer who knew little about oil drilling, but much about engineering. Some one explained to him the need for a steady combination of speed and pressure on the revolving drill. "I can make a gadget that will regulate that automatically," he said. True to his promise, he invented the "Drillometer," a device much like the differential of an automobile. One end of the "differential" is attached to the speed regulator, another to the engine that hoists the drill up and down. If the drill strikes a soft formation and begins to speed up, it is lowered and more weight is applied. If a snag is struck, the slowing of the drill lifts the weight from it. Simple, but effective.

DEEP drilling opens new possibilities to lure the oil man, for beneath old zones that have yielded fortunes may lie new pools of untold richness. One morning in June, 1929, drillers were lamenting a "twist-off" in Associated's Clarke No. 2, a former producer that was being deepened to explore new depths. Fishing with strange hooked tools, they sought to recover the lost drill stem, which filled the hole to within forty feet of the bottom.

Suddenly a column of oil, bursting from the well, shot up to the derrick top. It was the first indication of the amazing Lower Clarke zone, last and deepest of the prolific Santa Fe Springs strata, which caused that field's production to jump from 16,000,000 barrels in 1928 to 76,447,464 barrels in 1929.

WHY SEAPLANES FLY WITH BULLET SPEED

(Continued from page 39)

I was heading back along the coast for the harbor when I noticed a patch of ruffled water near the shore.

Sheer 1,000-foot cliffs rose from the sea at this point. Near the disturbed water, a narrow chasm, like a knife cut, had been worn through the bluffs by a mountain stream. From this wild ravine, narrower than the span of the Dornier's wings, a little breeze was blowing, produced by cooled air flowing down the cut. I swung the big boat toward the cliffs, opened the two 500-horsepower motors, and thundered straight for the mouth of the gorge.

Out of the tail of my eye, I saw the mechanic grab hold of his seat, snap his head around, and look at me as though he thought I had gone crazy. The cliffs loomed higher and higher over our heads. Our speed was increasing with every foot. As we hit the ruffled water, a crash seemed inevitable. Then the breeze, striking us head-on, lifted the ship up its slope in a skidding half-circle, I swung to the right and headed out to sea for the take-off.

In a water plane, you can make a turn like that at high speed. On a land plane, it would wipe off the landing gear. In skimming along the water, a seaplane or flying boat rides on its step, sunk only a few inches below the surface. So it is only the top "skin" of the water that resists sidewise movement, and this is insufficient to do damage. For this reason, a seaplane is able to land without difficulty at right angles to a current or while drifting sidewise in a cross wind.

WHEN Glenn Curtiss took off from the water near San Diego, Calif., in 1911, in the world's first seaplane, his machine was equipped with a single boxlike, flat-bottomed wooden float. A little later, the hydroplane step was introduced, increasing its efficiency. The next advance was the substitution of a V-bottom for a flat one.

In landing, the knife edge of the V cut into the water and reduced the shock. But suction around the sides of the first V-floats threw spray into the propeller and cockpit. So spray-strips, like automobile mudguards, were attached to the sides of the pontoons. However, a new type of V-bottom soon made them unnecessary. By curving the legs of the V inward in the form of two scallops, the spray-producing suction was eliminated.

The latest boats, such as were placed on the Lockheed monoplane flown to the Orient by Col. Charles A. Lindbergh, have a "double scallop" bottom. This gives a minimum of spray in running through rough water.

The two characteristics of a good pontoon or flying boat hull are "clean running"—that is, throwing up little spray—and having the least possible amount of resistance in traveling through the water.

At Cowes, England, in 1925, I tested a huge multimotored flying boat that had an inverted V-bottom like a seasled. It gave clean running in heavy seas, but its water resistance was so great that the design was abandoned. The greater the water resistance, the greater the power required to get a ship into the air.

BECAUSE of this fact, my transatlantic plans were almost wrecked by one of the strangest cases of added resistance on record. At the Azores, we made our final tests and found just what the Dornier would lift. Then there was a month's delay, repairing the radio and waiting for good weather.

A perfect day arrived. We filled the tanks, stored aboard our equipment, and charged out into the Atlantic for the take-off. The ship wouldn't rise. *(Continued on page 138)*

WHY SEAPLANES ARE SPEEDY

(Continued from page 137)

We tried again and again. It had risen before with the same load, but now it wouldn't get out of the water. In the harbor, I was sitting dejectedly on a wing-stub with my hand dangling in the warm water when a hard little lump on the side of the hull came off in my fingers. I looked at it and the mystery was solved.

The whole bottom of the hull was covered with barnacles and small mussels that had attached themselves during the month's delay. The increased water resistance of the rough hull, rather than the weight of the shellfish, prevented the take-off. When a diver cleaned off the bottom of the boat, the Dornier lifted easily from the water.

In developing air-and-water craft, designers were dealing with two elements. Sometimes they would produce machines that flew like birds in the air, but on water were tricky and dangerous. At other times the opposite would be true.

I remember one treacherous machine the pilots nicknamed "The U-Boat." Every time it would near flying speed, the nose of the hoat would be sucked down into the water and only by cutting the gun could the pilot avoid a "crash dive" to the bottom. Nobody knew what was wrong. The ship was one of the most beautiful I ever saw, its hull having smooth, curving lines. In the end, it was found that these lines caused all the trouble. The curve extended too far back. The bottom of the boat was like the top of an airplane wing. As speed increased, the water produced a down-suction just as the partial vacuum above a wing increases its upward lift.

ANOTHER design difficulty in early water planes concerned the necessity for putting the propeller high up to avoid the spray. When a pilot opened the throttle on these machines, the nose of the plane pointed down, and when he shut off the motor, it pointed up. This meant that if the engine cut out unexpectedly in the air, the ship was likely to pull up into a dangerous stall unless the man at the stick did some hair-trigger piloting.

Being high above the center of weight, the push of the propeller tended to drive the top of the plane ahead before the bottom, thus nosing the ship down. And when the propeller's push was suddenly removed, the nose naturally came up. On the latest boats the motor is mounted so it slants downward to the rear. This sends the slipstream, or wake, of the propeller down on the tail surfaces, holding the tail down and the nose up when the motor is running, and letting the tail rise and the nose go down when the blast from the propeller ceases.

Another recent improvement for seaplanes has been announced by the makers of Edo floats. Water rudders, that help in guiding a ship on the water, have been designed for attaching to the rear of the pontoons. The danger of slewing violently at high speed when landing with the rudders turned to one side has been eliminated in an ingenious manner. The steering surfaces are hinged so the pressure of the water at speeds over twenty-five miles an hour flips them up out of the way.

THE latest innovation in flying boat construction is reported by the Savoia-Marchetti factory at Port Washington, N. Y. A ship with a hull and framework made entirely of spot-welded stainless steel is nearing completion. It is expected to be both lighter and stronger than the usual wood or duralumin construction.

Under ordinary conditions, landing a water craft is far easier than bringing down a land plane. But on days when a light haze hangs over a river or lake it is almost impossible to tell where the air ends and the water begins.

A few weeks ago, I was flying down the Hudson River in a Loening amphibian. Near Peekskill, where I was to land, an early morning mist lay over the river. The beginner pilot who was with me wanted to make the landing for practice. So I let him go ahead. He throttled down the engine and went into his glide. He had just begun to level off when—crash! we struck the water.

Even an old-timer often misjudges the position of the water when coming down in a light haze. The best plan is to glide to within forty feet of where you think the water is and then switch on the motor. Keeping the plane running just above stalling speed, you can fly it onto the water in a long gradual descent that avoids the risk of "pancaking" or bouncing.

SOON after flying boats appeared, an inventor produced a device to warn pilots when they approached the water. A weighted wire hung over the bow of the boat. When it struck the water, a light on the instrument panel flashed on. The apparatus worked successfully, but it was needed so infrequently that there was little demand for it.

When the water is perfectly flat, without a ripple, it is also difficult to judge your height above the surface. I carry torn-up bits of paper in my pocket for such emergencies. By tossing them overboard, I can see them floating on the water and can judge where to level off. Once, on a still morning over Lake Constance, Germany, I used leaves drifting on the dead flat water as a guide in coming down. On another occasion, I landed in the flying boat at the mouth of the Loire River, France, by moonlight late at night. Ripples on the water reflecting the moonbeams showed me clearly where the surface lay.

Of course, flying seaplanes in a calm is one thing, and piloting them from rough water is another. The latter is the real test of a flyer's skill. Rough water is of two kinds, swells and waves. The worst of all combinations is waves on top of swells. Off the coast of Spain, in the Bay of Biscay, I once had to take off from a sea in which the swells were like a series of parallel mountains. The danger is that the ship will reach the crest of a swell with almost flying speed. Then it will hop off like a glider and sail down, crashing into the side of the next advancing wall of water.

HOWEVER, a seaplane pilot does not have to take off and land facing the wind as does a flyer at an airport. Usually, in heavy swells, the boat pilot takes off cross wind, running parallel to the waves, and lands the same way.

In rough weather, a pilot is likely to be too anxious to get his plane into the air. If he stalls the ship off the water, it will nose down and begin "porpoising" along in jumps, crashing onto the water at the end of each hop. The instant a ship begins to porpoise, I cut the gun. The chances of crashing are too great.

After my transatlantic attempt ended in a thrilling midnight landing with a flaming engine, 600 miles from shore (P.S.M., Nov. '31, p. 36), nearly a hundred inventors from all over the world wrote me letters. They had devised flying boats with wings that could he dropped off in a forced landing at sea so the hull could cruise off like a motorboat.

This illustrates one of the common misconceptions about *(Continued on page 130)*

WHY SEAPLANES FLY WITH BULLET SPEED

(Continued from page 138)

air-and-water craft. The fact is that tests proved our Dornier was better able to weather a gale with the wings on than it would have been with them off. As the foaming waves rushed toward us, the air in front of them was pushed forward, then lifted over their tops, just as soil is carried upward by the share of a plow. These currents struck the wings of the ship and helped boost us upward so we rode the waves like a cork. I am positive, in this way, we could have ridden out the strongest gale.

One of the strangest facts to those who do not understand flying boats is what they will stand in a storm. Once a fleet of winged boats stopped for the night at the flying base at the wild Scilly Isles, off Land's End, the southern tip of England. While they were riding at anchor, a storm swept in from the sea. White-topped ridges of water battered the hulls while a screeching gale howled through the rigging of their big wings. Then, as the violence of the gusts increased, the huge seven-ton boats lifted themselves bodily from the crest of an unusually high wave and flew at the ends of their big anchor cables like kites!

This year, 1931, is the twentieth anniversary of the first successful flight in an air-and-water plane. During these twelve months, the *DO-X*, capable of carrying more passengers than any other plane in the world, has crossed the Atlantic and flown in both Americas; the Supermarine racer has rocketed through the air at 415 miles an hour; and the pontoon-equipped Lockheed, flown by Col. Lindbergh, has followed a new northern trail to the Orient. In passenger service, record-setting, and sport, the machines that are at home in the air or on the water have come to the fore.

ANOTHER absorbing article by this famous designer, war bird, and test and racing pilot will appear in an early issue. Watch for it. Next month, Assen Jordanoff, noted flying instructor, tells what his students have taught him. Read the thrilling adventures of a veteran of the air in teaching tyros to fly. In January issue, out December first.

CALL PATAGONIA FIRST HOME OF THE MAMMALS

IN PATAGONIA, southern South America, creatures first began to walk. That is the conclusion of Dr. G. G. Simpson, American Museum of Natural History paleontologist, who has just returned from an eight-month journey of exploration. On its tablelands, he found what he calls undoubted evidence that it was the spot where mammals first originated. "We did not expect to have such astounding luck," he says. "We found the richest pocket of fossils I have ever seen." Most plentiful were those of a creature with shaggy hair about the size of a wolf. The specimens, he says, bridge a 50,000,000-year gap in the world's history.

HOP-HORNBEAM WOOD BEST TO HOLD NAIL

Wood from the hop-hornbeam tree of Wisconsin holds nails best, and that of the lowland white fir least well, among fifty-one species of wood recently tested for their nail-holding power by the U. S. Forest Service. In general, its experts found, the ability to hold a nail depends upon a wood's denseness, though this is somewhat compensated by the lighter woods' resistance to cracking.

DOPING A CAR FOR COLD WEATHER

(Continued from page 74)

wouldn't take a chance. If you're going to use alcohol at all, get the denatured grain alcohol. You never can tell when you'll get into a traffic jam on an extra warm day in winter with the wind just right and have the motor boil a lot of wood alcohol fumes into the car. Even the fumes of wood alcohol can do a lot of damage if you breathe enough of 'em.

"As for you, Jack," Gus continued, "if you use alcohol of any kind when you've got a perfectly good radiator that doesn't leak, you're wasting time and taking a chance on damaging your car. You need glycerine or ethylene glycol. I've got 'em both in stock. Neither one will boil away or give you any trouble. Which shall it be?"

"How should I know?" asked Jack. "Which is best? Does one cause more corrosion than the other or something?"

"Far as I can see there's no choice," Gus replied. "All the good brands are treated to prevent corrosion. As a matter of fact I think there'll be less corrosion with either than you get with plain water."

"What I can't understand," Jack said, "is why we should have so many new fangled anti-freezes on the market now when a few years ago everybody used alcohol and got good results."

"The main reason for that," Gus explained, "is the kind of motors we have in cars nowadays. Higher compression, and more power out of the same size cylinders naturally means more heat to be carried away by the radiator. Most motors now run a lot hotter than the oldtimers. Alcohol boils before many modern motors get up to their right running temperature. If you fix 'em so they stay cold enough not to boil away the alcohol, then you're letting yourself in for a lot of other troubles—mostly extra wear caused by excessive crankcase dilution and poor lubrication."

"How do you mean fix 'em?" Jack asked.

"LEAVE the radiator uncovered, for one thing, or if you've got a thermostat or an automatic shutter control, adjust it so it doesn't keep the motor so warm."

"If you do that, how do you keep the car warm?" Danny asked. "My car is fitted with a hot water heater."

"The answer to that is buy yourself a pair of fur lined boots," Gus smiled, "or else put in a heater that works directly from the exhaust pipe. The exhaust stays hot even when the motor is nearly cold."

"Gosh!" exclaimed Danny. "I think I'll have a new radiator core put in. What's the sense of fussing around all winter, worrying about the motor freezing into the bargain? Maybe we won't get new cars in the spring and I'd have a new radiator to buy then anyhow."

"I never did think much of makeshift jobs," Gus grinned.

NEW INSTRUMENT SHOWS WHICH ROOM IS SUNNY

WHICH rooms of a house will be sunny may be determined, even before the house is built, by an instrument perfected in England. Designed for architects and others, it consists of a base like a sundial and a small ball on a string representing the sun and its rays. By setting the base upon a house plan and moving the "sun" with the taut string along an inclined guide of accurate astronomical design, the hours of sunlight for any door, window, or lawn are found at once for any time of the year.

HE DOCTORS PROPELLERS

(Continued from page 37)

laid up because of a terrible case of "shudders." Beginning with the very first voyage, the vibration had been present; and it had increased until at last the propeller bearings burned out and the engine became crippled.

What was particularly puzzling about this case was the fact that there was no apparent cause for the trouble.

However, a careful examination with the pitchometer proved that not only did the blades vary considerably in pitch from each other, but that there were variations in pitch between different portions of a single blade.

WITH special machinery he h s developed, capable of exerting a pressure of more than 1,000,000 pounds, Godfrey soon smoothed out the kinks of pitch. The two wheels were replaced on the ferryboat. To the surprise of officers and crew, the boat glided off with the smooth grace of a yacht!

So impressed was the Army Quartermaster Corps with this demonstration that it soon inserted a clause in many of its contracts with propeller manufacturers that all propellers for its use must before acceptance be tested and certified by Godfrey.

Godfrey is willing to talk more about boats and propellers than about himself. Born in New Zealand, forty-seven years ago, he came to Seattle with his family when he was five. When he was in the teens he learned the intricacies of engine building.

In 1922 he became discouraged with the prospects of the engine-building business, and began turning over in his mind the possibility of entering some profession that had a bright future. Discovering nothing that suited him, he determined to create a business.

From his previous experience he knew that propellers were a fertile source of boat trouble. Godfrey felt that if he could devise an instrument that could, quickly and accurately, determine pitch, and machinery to correct the pitch, he would have answered a great need in the shipping world.

He studied geometry and trigonometry to enable him to make the necessary calculations. In 1923 he invented the pitchometer, and started his business of measuring propellers.

To check a propeller with the pitchometer, the propeller is first centered between two cones of steel. Bolted to the flat top surface of the upper cone projects a heavy graduated arm. Sliding on this arm is a vertical bar which has an angle-measuring device.

THE checking is begun by moving the vertical bar out to, say, a ten-inch radius. The feet of the angle device are adjusted so that they simultaneously touch the surface of the propeller blade, and the angle is noted on the scale. By referring this angle and radius to a similar angle and radius on a table he has compiled, the pitch at that particular point of the blade is found.

Considering that the west coast offered too small a field for his work, Godfrey came east and set up a small shop in Brooklyn. His first Brooklyn job came from the Marine Basin Company. He saw two old forty-four-inch wheels in their yard, bent and battered apparently beyond hope. As junk they would have brought about five dollars. Godfrey begged the owner for the chance to try to fix them.

In two days Godfrey brought them back. "But I want my own wheels!" said the shipyard man.

"There are your wheels!" retorted Godfrey.

It took some time to convince the man that he had not substituted new wheels.

Today, propellers find their way into his shop from a thousand individuals and shipyards at a rate which he can hardly handle with the help of six assistants.

MICROSCOPE DETECTIVES

(Continued from page 36)

trousers and under the microscope compared hits taken from the pocket-linings with the fiber specimens found in the guns. We not only proved the weapons belonged to the gangsters but we knew which gun belonged to which man."

In order to aid sleuths in identifying strange fibers, Frank Gompert, of the sheriff's office in Los Angeles, Calif., has collected specimens from all over the world. His unique "fiber museum" is said to contain upwards of 200,000 samples.

I LEARNED that often the microscope is called upon to examine bits of fiber under strange circumstances. In an eastern city, not long ago, a demonstrator for a company making bullet-proof vests sued his wife for divorce. Unfortunately, he failed to wear one of the vests he demonstrated in court. While he was testifying on the stand, his wife leaped to her feet, whipped a revolver from her purse and fired two shots. One went wild. The other ripped through the upper part of her husband's left lung. After a week in the hospital, it was thought he was on his way to recovery when he took pneumonia and died.

Had the shooting caused the pneumonia? That was the problem for the court. To find out, experts scraped the inside of the wound, made microscopic tests and found that fibers from the outer clothing of the victim had been carried into his chest, thus introducing the germs. The woman was held on a charge of murder.

Again, the versatile microscope plays a part in crime-solving by examining fibers and threads when fabrics have been cut or torn. Seen under a high-powered lens, a cut that looks perfectly straight to the naked eye appears as a jagged line. When the two halves are placed together, the thousand and one projections and indentations dovetail.

By this test, a murderer who wrapped his victim's head in a strip of cotton was run to earth. In another case, the revolver of a gunman was traced through a strip of tape wound around the handle. One end of the strip, under the microscope, matched the end of a coil from which it had been torn in the house of the suspect.

Paper fibers also often form a prize exhibit in the microscope-rooms of the crime laboratories. For instance, when a paper is creased the fibers are broken at the point of the fold, and an expert, by examining a document at this place, can instantly tell if writing has been added after the paper was folded. Usually, the ink runs slightly where the fibers are pulled apart. Sometimes, on hard-surfaced papers, there is a microscopic gap in the ink line at the bottom of the crease where the pen has jumped over the "ditch."

While visiting one eastern handwriting laboratory, I was recently shown a "perfect forgery." A forty-year-old note, held against an estate, had been raised from $10,000 to $100,000. The shape, size, and formation of the forged figures and letters would have fooled the most expert eye. The ink that had been used was identical with the original. Yet, when I peered into the round lens of the expert's microscope, I saw an instant proof of fraud. The paper fibers had been swelling and shrinking with forty years of alternate dampness and dryness. As a result, the ink of the original writing contained tiny cracks, Lilliputian canyons that split open the black ridges forming the letters and figures. But in the newer, added, writing, there was not a single crack!

In a score of other ways, microscope enlargements reveal forgeries. They expose retouched spots on fake signatures. They reveal slips made in reproducing legal seals, in printing counterfeit bills and in making spurious coins.

Frequently, I was told, ace sleuths, in solving a crime, never go near the spot marked "X." They lahor in their laboratories, painstakingly examining evidence submitted by trained assistants. In this manner, the late Dr. Alhert Schneider, head of the noted Berkeley, Calif., crime detection laboratory, revealed the secret of a fiendish murder plot.

On a fall morning, shortly after nine o'clock, a numher of people saw two men, a well-known chemist and a newly-hired assistant, enter the small laboratory where the scientist was conducting experiments with volatile liquids. Two hours later, neighbors rushed into the streets at the sound of an explosion. Livid sheets of chemical-fed flames streamed from the windows of the building. The fire had practically destroyed the structure before help arrived. Hacking their way into the smouldering ruins, firemen recovered a single charred hody. Through vestiges of clothing found under it, and a ring on the finger hand, it was identified as that of the chemist. His assistant had disappeared.

LIFE insurance companies, a short time before, had written large policies on the life of the scientist. They asked Dr. Schneider to make an investigation. From the hack of the victim's head, where it had been partially protected by a soaked blanket, an assistant brought him three unburned fragments of hair. Another assistant obtained from the home of the chemist a hairhrush he had used. Combings from it were compared under a microscope with the fragments taken from the body. The results became instantaneous headline news.

The chemist's hair, Dr. Schneider found, was fine, round and straight. The fragments taken from the head of the dead man were greater in diameter and oval in shape, indicating the victim's hair was curly. To the trained eye of the detective, this evidence proved conclusively the dead man could not have been the chemist.

The papers announcing this sensational discovery were hardly on the streets before a flash from Portland, Ore., sent the presses racing again. In a downtown hotel, there, a stranger had committed suicide. He had been identified as the missing chemist. His written confession revealed the whole fiendish scheme, hatched to defraud the insurance companies.

IN HIS laboratory, the plotter had murdered his assistant, hired because he was his double in size and weight. Then he had placed his clothes and ring on the body of his victim. After pouring either acid or bon-disulphide around the body, he had escaped unnoticed, leaving a time mechanism to ignite the volatile chemicals.

With a host of such dramatic exposures to its credit, the microscope has proved itself the standby of the scientific sleuth. Its world of invisible clues is solving an ever-increasing number of haffling crimes. In the hands of the painstaking, scientific crime-fighters of the laboratory, it has become a major weapon in the offensive against crooks.

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